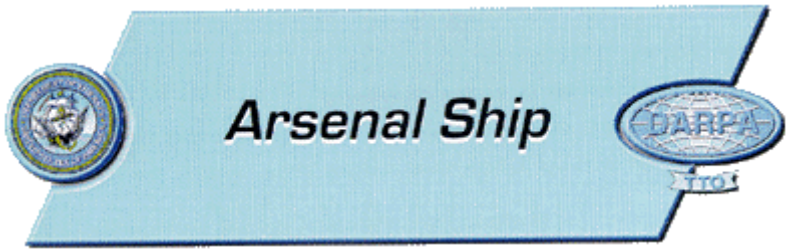

LESSONS LEARNED

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LESSONS LEARNED

OUTLINE

1.0 Executive Summary

1.1 Introduction

This report captures many of the lessons learned in executing the first two phases of the Arsenal Ship program, a period of about 22 months. It focuses on acquisition process-oriented lessons, rather than individual consortia technology initiatives which are proprietary in nature. This report was written by the Arsenal Ship Joint Program Office (biographies at Tab M), and the views expressed do not necessarily reflect DARPA or Navy concurrence.

The first two phases of the Arsenal Ship Program provided an excellent return on the Navy's and DARPA's investment. These two phases successfully demonstrated that industry, involved early in the ship design process, could develop an optimum mix of performance capabilities that could be accomodated within affordability constraints; successfully demonstrated teaming between combat system integrators and shipyards; and introduced innovative concepts in reduced manning, automated damage control, topside integration, and modular design.

1.2 Background

The basic requirement for the Arsenal Ship, established in a joint Navy DARPA Memorandum on March 18, 1996 (Tab A), was to satisfy joint naval expeditionary force warfighting requirements in regional conflicts by providing the theater commander with massive firepower, long range strike, and flexible targeting and possible theater defense through the availability of hundreds of vertical launch system (VLS) cells. To meet this warfare requirement affordably, the Arsenal Ship concept and design was to be straightforward and simple. Detailed requirements and concept of operations were defined in separate documentation (nine pages total), however, key elements for the Arsenal Ship included:

- Provide approximately 500 VLS calls, with the capability to launch Navy and joint weapons to support the land campaign;
- Integrate the combat system with Cooperative Engagement Capability (CEC) links to serve in, or as, the off-board control;
- Appropriate ship design features for survivability and ship self defense which could be incorporated at a later date if needed;
- Low ownership Costs through the use of innovative maintenance and operational methods, procedures, and technologies;
- Crew size not to exceed 50 personnel. The design objective will be to minimize crew size to the maximum extent below 50 which is technically feasible.

In the face of limited budget levels, the use of acquisition reform initiatives and streamlined contracting methods were paramount to meet the basic requirements of the Arsenal Ship in an affordable manner. To accomplish this, a non-acquisition category demonstrator ship was to be developed, in the water and ready for testing by October 2000, and which would have been convertible to a fleet asset at a future date.

In addition, cost was viewed as an independent variable, and early industry involvement with the development of a cooperative industry-government team was viewed as key to achieve Arsenal Ship goals. To minimize cost, off-the-shelf systems were to be used exclusively. Any development of new systems required the approval of ASN (RD&A). The cost of acquiring the first ship was not to exceed $541 million including the cost of concept development and competition. These funds were to be provided jointly by the Navy and DARPA with contributions of $371 million and $170 million respectively.

The non-ACAT Arsenal Ship demonstration program was created to evaluate sea-based massed precision firepower, while minimizing the risks in acquisition of approximately six ships. To ensure that the program remained affordable, a firm acquisition cost threshold for the production ships was established (Unit Sailaway Price $450M goal, $550M cap in FY96 $). A corresponding Life Cycle Cost threshold was also established (Operating and Support annual cost of $13.7M/ship [roughly a third of DDG-51]. This program was conducted using DARPA's Section 845 Agreements Authority so as to allow industry wide latitude in satisfying the Navy's requirements within this threshold. Agreements were structured to allow tradeoffs between cost and performance. Program success was to have been judged by the extent to which the Arsenal Ship met operational requirements.

A second purpose for this demonstration program was to accelerate the Navy's ongoing acquisition reform activities focused on buying improved ships at a lower cost. To this end, the joint program was to focus on exploiting DARPA's culture and experience in prototyping system programs. The Navy and DARPA anticipated the production Arsenal Ship contracts would serve as a model for future streamlining.

This joint Navy/DARPA demonstration program was conducted under DARPA lead, as articulated in a joint 28 May 1996 memorandum (Tab B), with an envisioned transition of leadership to the Navy in the testing and production stages of the program. The program was managed by a joint Navy/DARPA program office with the Program Manager reporting to DARPA. A small program office was mandated. DARPA, Naval Sea Systems Command (NAVSEA), and the Office of Naval Research (ONR) each provided two billets. It was expected that the program office would grow to a maximum of three billets each as the program grew to maturity. The Navy developed a concept of operations (CONOPS) (Tab C), and a Ship Capabilities Document (SCD) (Tab D), which the program office used to guide the Phase I and II trade studies conducted by industry. The Program Manager developed a program plan including major decision milestones, and a DARPA to Navy program transition plan.

Organizationally, the Arsenal Ship Program Manager reported to two committees for guidance and direction: the Steering Committee and the Executive Committee.

The Steering Committee included:

Director, TTO - DARPA (Chair)
Deputy Assistant Secretary of the Navy (DASN, Ships)

Assistant Director, TTO for Maritime Programs - DARPA
Director, Surface Warfare Plans/Programs/Requirements Branch
- OPNAV (N863)
PEO for Surface Combatants
Office of Naval Research (ONR33)

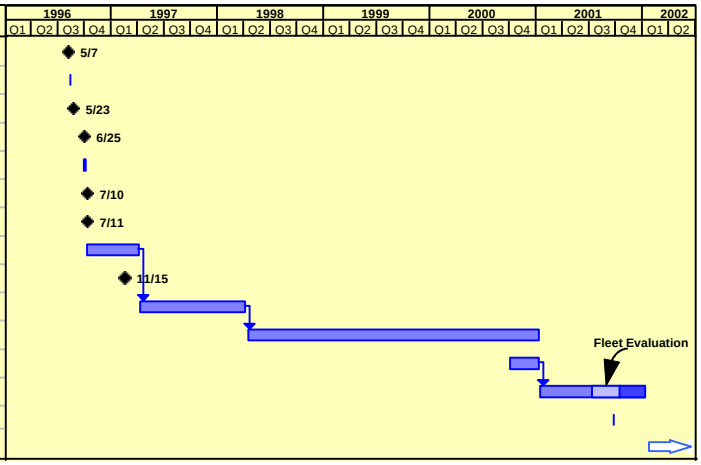
The Executive Committee included:

Director, DARPA (Chair)
Assistant Secretary of the Navy (RD&A)
Director of Surface Warfare (N86)
Commander, NAVSEA
Chief of Naval Research

The program was divided into six phases. Phase I was a six month Concept Definition effort for multiple industry consortia. Phase II was a twelve month Functional Design effort, originally for two consortia (expanded to three based on the robust designs of 3 teams. Phase III was to be a 33 month Detailed Design and Construction of the Demonstrator Ship, by one consortia. Phase IV was to be a twelve month Demonstration/testing phase, followed, if successful, by exercising the Phase V(a) Production option, Phase V(b) Conversion of the Demonstrator to production option, and the Phase VI Service Life Support of the class for the lifetime of the ships. The initial industry funding and schedule is arrayed below:

Initial Schedule & Funding Profile

Task Name	Start	Finish
Industry Program Brief	5/7/96	5/7/96
Industry Discussions	5/13/96	5/14/96
Final Program Solicitation Issued	5/23/96	5/23/96
Phase I Proposals Due	6/25/96	6/25/96
Phase I Proposal Evaluation	6/25/96	7/9/96
Phase I Source Selection Briefing	7/10/96	7/10/96
Phase I Contract Award	7/11/96	7/11/96
Phase I Concept Definition	7/11/96	1/9/97
Phase II Proposal Due	11/15/96	11/15/96
Phase II Functional Design	1/10/97	1/9/98
Phase III Detail Design, Construction	1/12/98	10/11/00
Phase IIIb Test Evaluation Planning	6/30/00	10/11/00
Phase IV Demonstrations	10/12/00	10/11/01
Phase V - Option Exercise	7/2/01	7/6/01
Phase VI - Service Life Support	TBD	TBD



Fiscal Year Funding Profile

Phase I (Multiple Awards) **$1M ea**
Phase II (Two Awards) **$15M ea**
Phase III } **(One Award)** **$167M $119M $103M**
Phase IV } **(One Award)** **$25M***

*** Phase IV T&E distribution between Gov't and Contractor to be determined**

Five Teams were awarded Phase I agreements on July 11, 1996, under the 10 USC 845 Other Agreements Authority, with the potential to execute through Phase VI of the program. This Other Agreements Authority excepted the program from the Federal Acquisition Regulations (FAR) and any military specifications and standards. The scope of Section 845 Prototyping Authority is explored fully in a DARPA General Counsel October 24, 1996, memorandum (Tab E). USD(A&T) implementation of 845 Other Agreements Authority within the Services (Section 804 of the FY97 Authorization Act) is included at Tab F.

Three Teams were awarded Phase II agreements for Functional Design effort on January 9, 1997. In April 1997, the original Arsenal Ship Demonstrator concept was expanded by the Navy and DARPA to include risk reduction efforts for the Surface Combatant of the 21st Century (SC-21) (Tab G) and the Demonstrator's name was hanged to the Maritime Fire Support Demonstrator (MFSD) (Tab H) to reflect this expansion.

The FY98 Appropriation Act appropriated $35 million of the requested $150.2 million for Maritime Fire Support Demonstrator. On 24 October 1997, the Secretary of the Navy reluctantly determined that continuation of MFSD into Phase III and further phases was unachievable (Tab I). Phase II activities were completed and the Arsenal Ship Joint Program Office closed operation on 31 December 1997 (Tab J).

1.3 Lessons Learned

1.3.1 Acquisition streamlining works. The process being followed by Arsenal Ship demonstrated a 50% reduction in acquisition time for the design portion of the ship compared to the traditional design approach. The Industry Teams were prepared to complete the detail design and build the ship in 33 months, again about half the normal time. This was primarily enabled by using an industry led acquisition operating under Section 845 authority, with industry having full trade space and responsibility for the design.

1.3.2 Price As Established (PAE) spurs innovation and drives down acquisition cost but increases risk. Price as established (PAE) was the approach taken throughout the Arsenal Ship Program. Price here means industry cost to manufacture and a reasonable profit (or return of investment to the company). A price goal was established early in the program. All designs were monitored by the contractor teams to ensure an affordable item at a price including all non-recurring and recurring costs to manufacture and a reasonable return on corporate investments or in other words, profit. All other aspects of the government desired capabilities were tradable against the price goal. This is different from Cost as an Independent Variable (CAIV). Cost as independent variable (CAIV) assumes two things; first, the government is monitoring and controlling the trade decisions to ensure affordability, and second, cost is only one of several factors to be traded. Requirements creep is most certain. CAIV in present government literature means a government program manager yardstick to consider trades against requirements.

After several months, all competitive teams were to fix their own price against their design or PAE. During later phases more trades could result. The contractor team should have responsibility for all trade decisions and be encouraged to use the trade space within the

government's desired capabilities to ensure an acceptable and capable product that meets PAE. PAE focused the design trades on mission essential performance, without requiring the use of legacy systems as GFE (Government Furnished Equipment). This resulted in designs that were engineered at a total system level, highly integrated, commercially-based, and low cost, while at the same time introducing new systems with some attendant risk. Industry Teams were prepared to meet the goal of $450M for the average production ship cost, about 1/3 less than early Navy estimates for the production ship. Risk reduction programs were key to achieving the PAE goals and worked effectively. Under the Arsenal Ship acquisition strategy, substantial elements of the risk were transferred from Government responsibility to Industry. In short, competing teams concluded “zero risk is unaffordable.”

1.3.3 Low manning is readily achievable. Manning is the largest single factor in life cycle cost, and accounts for roughly 40% of the annual operating and support costs of Navy ships. Reduced manning is the key to lower life cycle costs. The enablers to achieve lower manning among the Industry Teams included: commercial ship operating and maintenance practices, insertion of COTS technologies such as integrated bridge system; nested, remote sensors; and high levels of controls and C4I integration. The Arsenal Ship goal of less than 50 crew was easily achieved by the Industry Teams (who averaged 22 crew). Preliminary Navy estimates for Arsenal Ship were 269 crew.

1.3.4 An industry design competition could be more meaningful than a Government AOA (Assessment of Alternatives). Industry Teams produced an array of design solutions that were achievable and affordable, with better cost information than is possible within the Governmentís data base. Since the designs were optimized for each Teamís production capabilities and facilities, industry design alternatives were available at lower cost than Government designs, and had been measured against producibility metrics, so designs were at a much higher state of maturity.

1.3.5 Industry is fully capable of designing and developing complex Navy ships. The majority of design and production skills needed to produce Navy ships was assembled as a natural part of the teaming of the full service consortia. Industry Teams were able to find needed technical expertise for almost all design areas in the commercial marketplace. In selected cases (principally survivability, and weapons effects), some Government R&D Center expertise was obtained by industry under individual contract. During the downselect process, losing Team members became available to join the winners to develop even stronger Teams. This was encouraged in the Agreement between the Government and the Industry Team.

1.3.6 Significant cost savings in development and acquisition programs can only be achieved through program stability. Industryís willingness to invest its time, talent and resources to compete for 845 type agreements is strongly influenced by the clarity and stability of the program, as well as the ability to realize return on investment. The Arsenal Ship Joint Program Office left the CONOPS and key elements of the Arsenal Ship unchanged through the first two phases; this stimulated about a $5 million per team investment (Consortia IR&D) in Phase I, and approximately $15 million per team investment in Phase II. The potential for

achieving a reasonable return on investment for production Arsenal Ships, as well as future production SC-21 vessels rounded out Industry's motivation for their investment strategy.

1.3.7 Technology is already available for breakthrough performance. Technologies still ìunder studyî by the Government were readily incorporated in the Arsenal Ship designs based on COTS products. Areas of particular strength include: reduced manning; automation; information systems; communications/connectivity; propulsion machinery; fire fighting; maintenance and logistics. Effective passive survivability and signature reduction technologies derived from previous Government programs are also available in the Marine and Aerospace industry. Combined, these resulted in improved performance with major savings for both acquisition and service life costs at little technical risk.

1.3.8 Minimal Government direction is a key factor to success. In a typical Government acquisition program, extensive specifications, cost and schedule requirements, and oversight (DoDI 5000.2, as interpreted by program offices and oversight staffs) can result in an overly constrained environment and unachievable objectives. Further, large Government program offices provide multiple opportunities for redirection, levying of additional requirements, confusion and delay in administering acquisitions. Arsenal Ship, with a minimal set of technical objectives (9 pages of goals with no thresholds), coupled with an office size of six Government employees, kept industry's trade space open, communications direct, and delays to a minimum. Significant trust and mutual respect was a direct consequence of the more open and coherent dialog with Industry.

1.3.9 Adequate time is needed for Industry Team formation and growth. Much energy was spent by industry in the first two months of Phase I sorting out Team membership and Team relationships. At the start of Phase II, the average Team size increased from about 50 to over 200 people in a short time frame, which caused different design maturation rates among the Teams. The phases of the program were structured to allow seamless transition from one phase to the next. Industry did not take full advantage of the downselect decision period to position themselves for the next phase. Had they done so, the Phase transition would have been much smoother. Without this, an additional 2 months for Phase II would have permitted all three consortia to fully mature their functional design.

1.3.10 Competitive design solutions are a “package deal”. All aspects of the Industry Team's competing designs were not equal in performance, but each the PAE goal without containing any fatal design flaws. Achieving a notional “best possible ship” by having the Government attempt to integrate various aspects of each Industry design would have resulted in (a) holdback of the most innovative ideas from competing Teams (b) a Government directed solution, undermining the industry-based design responsibility and (c) a program that would not meet its PAE goal. The Government must understand (and participate in the underlying trades which lead to the winning design), and then accept the solution as the best compromise that can be achieved within the PAE constraint.

1.3.11 Section 845 permits “fly before buy” for Naval Ships with no lost time to full production. The Defense Science Board's 1996 Task Force on Defense Acquisition Reform

(Phase III) highlighted the time to field the average major weapon system at 16 to 18 years. Surface Navy ships have been no exception. Traditional surface combatant acquisition programs require five years to complete concept, functional and contract design, after a five to seven year research and development cycle. Following award of lead ship, production of the first vessel averages five years. Two years after lead ship award, the follow ship contract is let, when the lead ship has barely started construction, committing the Navy to procurement of many ships before the first one is even delivered.

Using Section 845 authority, and involving industry at the inception of the program, cut the development cycle in half. The Arsenal Ship demonstrator would have been available for testing after just four years of design and production. The production decision could then be based on actual test data, allowing a ship to be acquired in a "fly before buy" fashion, reducing cycle time and accelerating technology insertion into the fleet.

1.3.12 R&D Funding must be properly balanced with production costs. Industry's limit of $389M for development of the demonstrator ship was extremely challenging as compared to the average production cost goal of $450M. Industry pushed some software development to the production ship to reduce demonstrator ship non-recurring costs, with attendant reduction in demonstrator capabilities and increased production risks.

1.3.13 Industry lead for acquisition is a permanent “fork in the road”. Industry's freedom to balance the PAE tradespace equation necessarily includes their ability not to choose Government developed systems. This has implications for the Government's R&D investment strategy, the infrastructure currently in place to support subsystem development (Participating Managers [PARMS]), and equipment configuration control (outsourced and privatized to industry or centralized with the Government). The net effect could be to lower total Life Cycle Costs by attacking infrastructure as well as taking advantage of the ommercial marketplace.

2.0 Program

2.1 Acquisition Strategy

2.1.1 Background

The DARPA High Altitude Unmanned Aerial Vehicle Program (Tier II+) provided the model for the Arsenal Ship acquisition strategy. Tier II+ was the first to use DARPA's Section 845 authority, granted to DARPA in the FY 94 Authorization Act.

Like Tier II+, the Arsenal Ship acquisition strategy was a multi-phase competitive procurement, with each phase reducing the number of competitors and increasing the maturity of the design for both the Demonstrator and production ships. The central element of the strategy was to use competition, with each of the Industry Teams committing to an irrevocable offer for the production ships at the end of Phase II. Phase I's Concept Design was awarded to all qualified full service Teams who could potentially perform all phases of the program. Phase II was to be awarded to two Industry Teams for the Functional Design (similar to Contract Design in maturity). The downselect decision instead awarded three Industry Team agreements based on three very robust Industry designs. Phase III, detail design and construction for the Demonstrator, as well as a priced option for five production ships, was to be awarded to one Industry Team.

Industry was encouraged to form teams to include all of the requisite analysis, design, build capability, and life cycle support required to execute the entire program. The intent was to encourage the creation of a Team where individuals applied their expertise irrespective of company affiliation. This could manifest itself as a joint venture, a limited partnership, or other corporate structure. The classic Prime/Sub relationship was not precluded, but alternative teaming arrangements were suggested as a way to break down corporate stove pipes, as well as achieve efficiencies and save costs.

The use of the Other Transactions Authority eliminated most of the procurement regulations, including those in FAR/DFARS (see Tab E). This allowed a streamlining of the process and shortening of the schedule, especially the time taken to conduct source selection by the Government. It should be noted that even though most of the "rules" are waived by the authority, a review of DoDI 5000.1 showed that the spirit and intent of DoD acquisition policy was being followed. Specific procedures prescribed in DoDI 5000.2 were not emulated.

Concept of Operations (CONOPS) and Ship Capabilities Documents (SCD) were provided as goals (Tabs C and D). The stated philosophy of "no requirements" effectively put responsibility for cost and performance on each Industry Team, and gave them the trade space necessary to achieve PAE goals.

A PAE range of $450M to $550M was established for the average Unit Sailaway Price (USP) of the five production ships. USP and the manning limit of 50 people were treated as the program's only hard requirements.

2.1.2 Lessons Learned

2.1.2.1 Effective competition motivated the Industry Teams to meet the program goals of cost and performance. Clearly the three Phase II Teams felt the competitive pressure of the other consortias and worked hard to create a competitive advantage. It is doubtful that consortia full effectiveness or corporate CEO level participation could have been achieved without the benefit of competition.

2.1.2.2 Industry could effectively form teams containing the requisite capability to perform the contract. The three Teams awarded Phase II agreements created effective organizations that operated mostly as a single unit. However, the members did not lose all of their corporate identity. This was manifest in the degree to which individual company cost data was closely guarded.

2.1.2.3 The shortened source selection process allowed the multi-phase process to work. Historically, the largest issue with pursuing a multi-phase program was the schedule penalty mandated by a lengthy source selection process, often lasting over six months. For Arsenal Ship, slightly less than two months were scheduled for both the Phase II and III downselects, with the selection date cast in concrete and put on all of the principals' schedules months in advance. Government access to Team's designs throughout their development, rather than only at source selection time, was critical to being able to execute the evaluation on a short schedule. The climate of rapid prototyping within DARPA, the willingness to explore new concepts, and the focused support by Director, DARPA, greatly facilitated this process.

2.1.2.4 One of the advantages of using the Agreements Authority was deleting "protest avoidance" from the process. Many of the rules established by the acquisition community over the years to avoid litigation have become cumbersome and detrimental to an efficient process. Although the integrity of the individual Arsenal Ship Team design and business data were jealously guarded, the "fairness" rules [1], for example, were eliminated, a fact which greatly improved the ability of the Government to support and communicate with the individual Teams.

2.1.2.5 When cost is the only requirement, it is essential that both the development budget and PAE goal be achievable and balanced. The $450M PAE goal for average production USP turned out to be a good number and universally supported by industry. Industry's limit of $389M for development of the demonstrator ship was extremely challenging as compared to the average production cost goal of $450M. Industry pushed some software development to the production

[1] The so-called "fairness" rules require the government to provide the answers to one team's questions to the other teams. Being a version of "Other Transactions", Section 845 agreements are not protested in the General Accounting Office. Protests to the Agency and protests to Court (where the standard is illegality or arbitrariness) while available under Section 845, are deemed more predictable and less threatening than the GAO process.

ship to reduce demonstrator ship non-recurring costs, with attendant reduction in demonstrator capabilities and increased production risks.

2.1.2.6 A streamlined acquisition process can significantly reduce the time and cost of bringing the product to market. The process being followed by Arsenal Ship demonstrated a 50% reduction in acquisition time for the design portion of the ship compared to the traditional design approach. The Industry Teams were prepared to complete the detail design and build the ship in 33 months, again about half the normal time. This was primarily enabled by using an industry led acquisition operating under Section 845 authority, with industry having full trade space and responsibility for the design.

2.1.2.7 One power of Section 845 Authority was in changing the mindset of the participants. The acquisition process currently in place incentivizes risk averse behavior, and stifles innovation. True acquisition reform and streamlining is possible if all the rules are taken away first and then reinserted on a case basis, such as for security and explosive safety. If each exception to the conventional rules must be justified, streamlining will not occur. Section 845 lets good business decisions govern.

2.1.2.8 Developing a long term vision and fully disclosing it to industry at the outset sets the stage for the entire program. In order for industry to plan for and invest in a program it has to know the Government's plans. Industry can seek this through the back door or Government can put the word out openly and consistently. Arsenal Ship sketched the program vision in two industry day sessions early, and then reinforced the vision themes at each industry interaction.

2.1.2.9 Allowing industry to set requirements increases design innovation. By not invoking any requirements, the Government gave Industry the total trade space for the overall design and the subsystems selection. Consequently, the use of new technologies integrated in different ways was facilitated, especially in the areas of communication, information systems and topside integration. Opening the development filters permitted the next logical step from the Goldwater Nichols Act of 1986; joint warfighting design at program inception.

2.2 Contracts (Agreements) and Legal

2.2.1 Background

2.2.1.1 Key Events

Phase I	
Draft Solicitation and Industry Briefing	7 May 96
Industry Discussions	14 May 96
Final Phase I Solicitation	23 May 96
Phase I Proposals Received	25 June 96
Phase I Selections Announced	11 July 96
Negotiations Concluded (Agreements executed - five Teams)	Aug 96
Phase II	
Draft Solicitation	13 Sept 96
Final Phase II Solicitation	3 Oct 96
Phase II Proposals Received	15 Nov 96
Phase II Selections Announced	10 Jan 97
Negotiations Concluded (Agreement mods executed (3 Teams)	Feb 97
Phase III	
1st Draft Solicitation	16 Jun 97
Draft Phase III Model Agreement Modification	15 Jul 97
Commence Phase III Agreement Mod negotiations	Aug 97
2nd Draft Solicitation	1 Aug 97
Final Phase III Solicitation	15 Sept 97
Cancellation of Program/Solicitation	30 Oct 97
Phase III Proposals Due	14 Nov 97
Phase III Award Scheduled	16 Jan 98

2.2.1.2 Approach The contracting approach for the Arsenal Ship program was to utilize P.L. 103-160 Section 845, Other Transactions Authority. This authority was provided to DARPA by the Congress in FY94 and has since been passed on to the military services by PL 104-201 Section 804. DARPA had experience with using 845 authority on other R&D prototyping projects. The Arsenal Ship Program's acquisition strategy was modeled after DARPA's Tier II+ program for Unmanned Aerial Vehicles. Use of Section 845 Authority allows for the procurement of prototypes outside FAR and DFARS regulations. Additionally, the Arsenal Ship Program was designated as a "non-ACAT" program (Tab A) , relieving it from the requirements of DoDI 5000.2. The Contracting Officer was free to negotiate terms and conditions specific to the individual needs of the program.

There were several motivating factors that support use of Section 845, including: 1) enticing non-traditional DoD companies, at both the prime and subcontract level, into the business; 2) facilitating insertion of commercial technology; 3) encouraging innovation, and; 4) decreasing the overall time and cost to design, build and deliver a ship.

The solicitations for each Phase of the program contained a "model agreement" with notional terms and conditions appropriate for that particular phase. Industry Teams were free to propose their own terms and conditions to the agreement based upon their particular circumstances. Agreements were then negotiated with each Team individually.

2.2.2 Lessons Learned

2.2.2.1 Non-traditional DoD companies are willing to do business with the Government using Section 845 Other Transactions. During Phase I of the program, one non-traditional company participated at the prime contract level. They proposed the use of a unique construction technique to which it owns patents. Use of Section 845 definitely provided an avenue for this Team to propose use of its proprietary technology because FAR/DFARS rights were not invoked during the competitive process. Additionally, non-traditional DoD companies also participated at the subcontractor level. Hopefully, this will lead to new business relations between traditional and non-traditional DoD companies and facilitate the introduction of the latest commercial technologies into Government acquisition.

2.2.2.2 Industry retention of most data rights under Section 845 facilitated innovation. Section 845 allowed for modified data rights which encouraged innovation during competitive phases. Industry Teams were allowed to retain data rights in the event they were unsuccessful during any downselect process. Teams were eager to put forth their best efforts without the fear that their innovations would be taken by the Government and distributed to other Teams. The Government clearly stated its intent with regard to data rights at the onset of the program - i.e., should the Team be chosen to construct the MFSD/Arsenal Ships, the Government wants rights to all data necessary only to maintain, modernize and support the ships. Rights to data would be defined by what the data is used for, instead of who paid for or prepared the data, as is the case under FAR/DFARS data rights clauses. Defining rights by their usage, as opposed to whether the Government paid for the rights, was believed to be a better approach to facilitating proper use of the data.

2.2.2.3 The intent to eliminate Government Furnished Equipment (GFE) facilitated innovation during the competitive phases of the program and could dramatically reduce the Governmentís risk of claims. No GFE was envisioned under the Arsenal Ship Program. This allowed for maximum design flexibility and took the Government out of its GFE responsibility role. This approach allowed for extensive review of new ways to satisfy the Government's technical requirements while potentially reducing production, maintenance and installation costs. Elimination of GFE placed the Industry Team in charge of the final product and greatly reduces opportunities for claims related to poor specifications, late GFE, inoperable GFE, etc. Some Teams discussed the potential use of GFE for particular systems if it appeared that it would be more economical for the Government to purchase a system through a quantity buy. The Arsenal Ship program was concluded before the full implications of such an approach could be explored or negotiated.

2.2.2.4 Access to data created under traditional Government contracts for legacy systems is extremely difficult. Because of the Arsenal Ship's operational interdependency on Government

legacy systems already in the fleet, access to data on these legacy systems was necessary in order for industry to perform design trades and engineering development. Access to data on Government legacy systems proved to be extremely difficult and time consuming despite extensive efforts by the Industry Teams and the ASJPO. The experience indicates that despite data rights provided by the FAR/DFARS, Government offices either questioned the Team's rights/ability to utilize any of Government's data or simply refused to provide it to other Government agencies for use on their programs. As a result, industry had to make assumptions regarding legacy system operations or even in some cases reverse engineer aspects of their design to ensure compatibility with legacy systems. Such action is time consuming, inefficient, potentially costly and underscores that traditional data rights clauses are counter productive.

2.2.2.5 The implications of an "irrevocable offer", which fixed the cost of production units, provided tremendous leverage to the Government and incentive to the Industry Teams to design to cost. At the conclusion of Phase II, all competing Teams were to provide an irrevocable offer to build five production Arsenal Ships at a fixed price. The detailed design of this Arsenal Ship would be defined during the Phase III construction of the MFS Demonstrator. Industry Teams were driven to propose the best capability for the money as a result of competition. However, they were also driven to develop a design that was realistic for the cost as a result of the irrevocable offer. If the design proved too expensive, the Industry Team would lose money on the production ships. However, if the design lacked in capability, the Industry Team ran the risk of not being continued in the program. These dynamics were created to facilitate true PAE design development and credibility in cost estimating. All Industry Teams viewed the Irrevocable Offer seriously from a contractual stand-point. The Irrevocable Offer drove Industry Teams to develop the most realistic, vice optimistic, cost estimates because they were contractually committed for these estimates at a fixed price. Negotiations of contractual language pertaining to the Irrevocable Offer were extremely complex and time consuming.

2.2.2.6 Negotiation of Section 845 Agreement terms and conditions facilitates greater understanding between the parties. Use of Section 845 Other Agreements Authority, provides both Government and Industry with the opportunity to deviate from traditional DoD terms and conditions when it is appropriate for the circumstances. With such opportunity comes a great responsibility to fully understand all technical and business aspects from which the Industry Team is operating. It allows both sides to analyze why a particular procurement can or cannot be performed under traditional terms and make exceptions to such terms if it will facilitate development under the program that will ultimately benefit both the Government and Industry. As a result, negotiations may become very complex and require understanding of industry's motives and concerns in order to determine what is in the best interest of the Government. It is extremely important that legal and technical personnel, as well as contracting personnel are actively involved in the negotiation process.

2.2.2.7 Effective implementation of Section 845 authority required close teamwork among the Government's contracting, legal and technical team members. The lack of established rules or regulatory guidance inherent in the use of Section 845 authority necessitated close communication between the Government contracting, legal and technical team members. Two major attributes contributed to this successful working relationship. First, the small size of the

program office allowed for rapid access to the necessary team members, especially the program manager, for discussion and decision. Second, the team members in the ASJPO were specifically selected for their ability to be open-minded, flexible and willing to experiment with the authority granted under Section 845. These attributes were particularly important in the contracting and legal team members, whose personnel have been traditionally viewed as impediments. The support provided by DARPA General Counsel and DARPA Contracts Management Office, was invaluable.

2.3 Role of Government

2.3.1 Background

2.3.1.1 ASJPO Relationship to Industry Teams

ASJPO objectives differed by program phase. During Phase I, the strategy for engagement was guided by the objective to permit uninhibited concept exploration and innovation by Industry Teams. To this end, Government involvement was structured as "objective" in nature, that is, data or calculation results were made available to the Teams but no advice of any kind was provided. The resulting industry-led efforts produced the desired significant innovation as characterized by:

- Major system innovations
- Independent, highly competitive cost estimates
- Introduction of commercial practices
- Aggressive schedules
- Effective teaming of systems integrators and shipbuilders

These accomplishments, coupled with the compressed schedule, effectively locked in the innovative concepts at the total system level and most of the associated life cycle cost benefits expected.

The objective for Phase II was to ensure successful functional design development that would result in highly desirable competitive proposals for construction. This objective demanded a more pro-active involvement to ensure the development of a ship that the fleet would evaluate positively in all areas. This approach could be taken without jeopardizing the Phase I success because:

- Remaining trade-offs were primarily at the subsystem level with limited cost impact
- Operational (user) input is more important as design detail unfolds
- Government had specific areas of expertise not generally available from industry (e.g., survivability)
- Under Section 845 Agreements, industry was not required to take Government advice

This last competitive phase was the best opportunity to encourage industry to improve weakness in their programs, improving the chances that the "all or nothing" operational test would prove a success and move us into the Arsenal Ship production during Phase V. Thus, ASJPO conveyed its views as a continuing "report card" during the process, rather than when it was too late after the final downselect. In addition, with such a tight schedule, time was of the essence in letting industry know where to focus additional effort rather than experiment with paths that have proven unsound in the past. ASJPO's role during Phase II was thus to:

- Interact in a supportive way on a minimally invasive basis during reviews, technical interchange meetings, and internal team meetings. Coach each Team to be the best they can be within the context of their approach.
- Encourage consideration of out-of-the-box opportunities for technology insertion and business practice reform. Provide real-time feedback.
- Facilitate access for Teams to Government offices, information and software.
- Continuous involvement of ASJPO personnel in the design reviews and open discussions increased understanding of the approach, allowed for identification, disclosure and correction of major deficiencies and shortened the evaluation process following formal proposal submission. It also increased productivity on both sides.

ASJPO questions got the Industry Teams thinking, and stretched their decision space. Great care was taken not to imply direction. The ASJPO core members quickly embraced this new role and used it to great advantage. Training external Government personnel brought in to provide analysis and technical advice to adjust to this non-traditional role was an on-going process. This new role on the part of the Government was viewed as crucial to the success of the program.

The Industry Team members faced a similar cultural shift. It took some initial convincing on the part of the ASJPO before the Industry Teams believed that the program office was serious in pursuing a more flexible and commercial-like way of doing business.

During Phase III it was anticipated that a very close working relationship with the single winning Industry Team would evolve, including on-site ASJPO representatives who would answer questions and facilitate getting Government data, coordinating program functions with other Government activities (such as WSESRB, fleet operational testing, INFOSEC security, testing ranges, etc), and perhaps even participate directly in software development via the Government R&D Centers . However, the responsibility for defining the best product for the fleet would remain with the Industry Team.

2.3.1.2 ASJPO relationship to support Contractors and Government R&D Centers

ASJPO recognized prior to the initiation of Phase I that specific expertise in analysis of ship motions, survivability, signature measurement, C4ISR, Life Cycle Management and ship production was needed to augment the Program Office. Contractual arrangements were negotiated with several private companies including: SYNTEK, Vail, SPC, and LMI. Additionally, task statements were put in place at NSWC Carderock, NSWC Dahlgren (to include Coastal Systems Station), NAWC China Lake (to include Point Mugu), NSWC Port Hueneme Division East Coast Operation, NCCOSC NRaD, JHU/APL, and NRL, to provide support to the ASJPO. These particular private industry Government Laboratory personnel were identified as source selection assistants, and were barred from interacting with Industry IPTs. All personnel included in internal ASJPO activities submitted Financial Disclosure Statements which were screened and approved by DARPA General Counsel for potential conflict of interest.

2.3.1.3 Government R&D Centers relationship to Industry Teams

ASJPO made available to the Industry Teams, government services that could not be obtained from private industry. A Phase I Memorandum of Agreement (MOA) (Tab K) was negotiated between NSWC and ASJPO that outlined the allowable interaction with industry during the first phase of the program. This allowed the Laboratories to provide objective products and services, non exclusively.

In Phase II, the relationship between the Industry Team and the Laboratories was expanded (Tab L) to include lab participation on Industry IPTs. Great flexibility was provided by the MOA; however, because of R&D Center concern with the legal restriction that they not compete with private industry, R&D Center personnel were slow to start work on industry IPTs. To alleviate this problem during Phase II, funding ($450k per Team) was made available at the R&D Centers directly from ASJPO to support each Industry Team. Industry Teams developed Statements of Work for this support since the Government itself (ASJPO) was providing the funds, the R&D Centers felt much more at ease with industry requests. This arrangement avoided any competition with industry and worked extremely well.

2.3.1.4 ASJPO and Industry Team relationship to PARMs

Within the trade space available to the Industry Teams to satisfy Arsenal Ship design goals, was the opportunity to select legacy Navy systems. The use of legacy systems in many cases was more attractive than developing new ones based on investment required, and because these systems have passed the WSESRB, OPTEVFOR and other safety/operational checkpoints in other developmental programs. These systems could be obtained either as Contractor Furnished Equipment (CFE), or purchased through the Navy PARMS. PARMs (PARticipating Managers) are the Government program offices responsible for individual Navy systems such as ATWCS, CEC, and SSDS. Systems of primary interest to Arsenal Ship Teams were ATWCS, AFATDS, and CEC.

The PARMs were receptive to making hardware available to the Arsenal Ship Teams, but expressed concerns about requests for the release of source code software to Industry Teams. They cited the difficulty in maintaining configuration control, plus the apparent liability of the PARM for performance anomalies in his system but was not under its control. As a consequence, PARMs were unwilling to release Government owned software for Arsenal Ship program use.

These concerns were the subject of an Arsenal Ship Offboard Systems Working Group, discussed in the C4I section of this report. Although not resolved during Phase II, it was hoped that a good working relationship could be developed during Phase III when only a single Industry Team would have interest in modifying source code. Initiatives in ATHENA working groups would likely have facilitated this process.

2.3.2 Lessons Learned

2.3.2.1 A small Government program office is sufficient when the total system design responsibility is in industry's hands.

The six Government personnel and six technical SETA proved adequate to monitor the consortias' progress, without imposing excessive oversight. By maintaining a daily consortia calendar across the teams, ASJPO could be physically present at the majority of design interactions by the teams. By locating access to their Integrated Product Design Environments (IPDE) at ASJPO, real time accessing of trade studies, IMS, IMP, 2D and 3D CAD/CAM models permitted virtual presence for those periods when ASJPO could not be physically present.

2.3.2.2 Industry welcomes openness of Government feedback. Industry was solicitous of Government feedback, to avoid revisiting errors of previous design efforts (which cost time and money), and to hear directly from the customer on likes/dislikes. They welcomed the openness of ASJPO comments on their progress. This relationship was enabled by two aspects of the Agreement; no claim provisions and no unilateral Government direction.

2.3.2.3 Providing expertise and ìlessons learnedî to Industry is a new Government role. Much as it was difficult for industry to accept full design responsibility at the beginning of Phase I, it was equally difficult for the Government to provide advice rather than give direction. Government retains a wealth of knowledge and operational experience that is indispensable to industry's design/build process. ASJPO called on technical specialists to provide briefings on survivability, combat systems interfaces, and Joint warfighting C4ISR. Access to intelligence reports, studies, and government designs were also facilitated by ASJPO. The guidance to Government personnel was that information exchange was acceptable, but that design mandates were not.

2.3.2.4 Government intervention was required in obtaining data, access, and equipment. Industry does not have authority to compel PARMs or System Command headquarters to provide information and access to data or equipment. ASJPO frequently had to exercise such authority.

2.3.2.5 Safety and security cannot be delegated to industry. Industry's responsibility for and integration of all aspects of the design/build product requires a special interaction with the Government Program Office in the case of safety and security. The Program Office is ultimately responsible for personnel and ordnance safety. Extant Government agencies (WSESRB and INFOSEC, for example) do not respond to private industry, but are chartered to respond to the Program Manager. In this special relationship, the Government must fully understand the design, and certify its safety.

2.3.2.6 Direct funding of R&D Centers by the Program Office is essential to performance of some tasks. Due to legal restrictions on Government R&D Centers ìnot to competeî for services available from private industry, direct Government funding is needed to provide flexibility for some industry tasking. For example, combat system engineering is available from a variety of industry sources; however, for a specific system, this may not be true. In this case, the Government must identify work-arounds to facilitate competition.

2.3.2.7 The Government team should have expertise, insight into, and understanding of Teams' business decisions as well as technical decisions. In some cases the Industry Teams made design decisions because they were either the developer of a system/software, because they

could not get detailed information about a system/software developed by others, or because their real market for a particular system is another program. The Government team needs to understand the motivations which underlie specific design decisions in order to assess if those design trades yield the best solution.

2.4 Funding

2.4.1 Background

The funding for the Arsenal Ship program was initially laid out in the Memorandum of Agreement (MOA) for the Joint Navy/DARPA Arsenal Ship Demonstration Program between Mr. Larry Lynn (Director, DARPA), Mr. John Douglass (ASN(RDA)), and RADM D. J. Murphy, USN (N86) in May 1996 (see Tab B). The cost of the R&D program for the Arsenal Ship Demonstrator was determined to not exceed $520 million including the cost of concept development and competition. The Navy DARPA joint funding profile was:

	FY96	FY97	FY98	FY99	FY00	FY01	Total
Navy	$4.0	$25.0	$141.0	$90.0	$80.0	$10.0	$350.0
DARPA	$1.0	$15.0	$47.0	$50.0	$36.0	$21.0	$170.0

In the same MOA the Navy agreed to provide its share of the funds to DARPA at the beginning of each fiscal year.

In January 1997, during the Phase I to Phase II downselect, three team's designs were determined to be of such value as to warrant their continuation into Phase II. The cost of adding a third Industry Team to Phase II was calculated to be $21M which the Navy agreed to fund. The $21M was split funded between FY97 ($9M), and FY98 ($12M).

During the PR-99 review process, the Navy redistributed $50M from FY98 to FY99; the overall Navy total of $350M remained the same. A dialog with industry determined that this revised funding stream could be accommodated without impacting the delivery and test schedule of the Demonstrator.

2.4.2 Lessons Learned

2.4.2.1 Funding Navy Research and Development (R&D) Centers/University Affiliated Research Centers (UARC) to Support Industry was necessary. Money sent to R&D Centers from ASJPO on behalf of the Industry Teams was necessary to maintain each Team's competitive edge and to allow for specific support. R&D Centers were allowed to perform any kind of support work without regard to "non-competitive" rules of accepting money directly from industry.

2.4.2.2 The ability of a University Affiliated Research Center (UARC) to support Industry needs to be broadened. Industry relationships with UARCs are much more difficult to establish than those Government Laboratories with DBOF funding. UARC's, much more than DBOF laboratories have been concerned with maintaining their appearance of objectivity with its many customers. The legal barriers of industry UARC interaction need to be more fully explored in the future to enable a much needed dialog.

2.5 Source Selection

2.5.1 Background

The Arsenal Ship Program utilized "best value" in determining the successful offerors for each phase of the program. A new solicitation was released for each competitive phase of the program that contained the source selection criteria applicable to that particular phase. The entire solicitation, including source selection criteria, was released to industry in draft form to allow them an opportunity to provide input and ensure clarity.

Source Selections for all Phases of the Arsenal Ship Program were performed in accordance with the approved Source Selection Plans. A new plan was prepared and approved for each consecutive phase of the Arsenal Ship Program. The Source Selection Plans were the same in structure and format to those prepared under traditional Government source selections. All source selection criteria and any information regarding its interpretation were contained in the solicitation. The source selection plan did not provide any elaboration of the selection criteria beyond that which was shared with industry in the solicitation.

The Arsenal Ship source selection approach was to perform an integrated technical, financial and management review of each Team's proposal. All source selection participants were required to attend one of several briefing sessions that outlined the source selection process, criteria and schedule. Source selection participants were divided into teams based upon their area of expertise. However, there was cross-over of personnel on all teams (i.e., some technical team members were also cost or management team members, etc.). The contracting, legal and technical team members all read and commented on all parts of the proposals and all participated in the discussions and selection of the ultimate awardees. Each team had a designated team leader who coordinated the team's evaluation efforts. Team leaders met briefly each morning to address questions or issues that may have affected the other teams' efforts and ensured a free exchange of ideas and information across the technical, financial and management disciplines.

In addition to the written proposal, oral presentations were held with industry approximately three weeks after receipt of proposals. Dates for oral presentations were assigned to each Industry Team by random drawing. All Teams were provided equal time to present highlights to their proposal. Oral presentations provided the ASJPO with the opportunity to clarify aspects of each Team's proposal. The solicitation specifically stated that oral presentations were not an opportunity to revise proposals and that the Government did not intend to request revised proposals as a result of the oral presentations. All oral presentations were held at the Team's facility and were video taped, with a copy to the Government. Only ASJPO personnel attended these oral presentations.

Evaluations from all source selection participants were consolidated into team briefings that were presented to the Source Selection Evaluation Board (SSEB). The SSEB then provided these team briefings to the Source Selection Advisory Committee (SSAC), along with its recommendations for award, over a period of two days. The SSAC was provided an opportunity to comment and question the results of the SSEB. A consolidated briefing, including the

comments and recommendations of the SSAC, was then delivered by the SSEB to the Source Selection Authority (SSA). The SSA made his decision based upon this briefing within a day.

After the award announcement, detailed debriefings were held with both successful and unsuccessful offerors covering cost, management and technical issues.

2.5.2 Lessons Learned

2.5.2.1 Detailed debriefs to successful offerors provided Teams full insight into perceived strengths & weaknesses which allowed them to improve their efforts in subsequent phases and reduce risk for the program. The ASJPO provided detailed debriefs to all offerors, including successful offerors. The source selection brief given to the SSA was used as the basis for detailing strengths and weaknesses in the Teams' proposals. The detailed debriefs to the successful offerors proved extremely beneficial at enlightening the Teams regarding areas where the Government perceived excessive technical risk, questioned costs or the management approach. All Teams made an extensive effort at redressing questionable areas noted in the debriefs. This led to improved designs and overall risk reduction for the program. Industry commented that they felt these debriefs were extremely beneficial, and the best they had received in twenty years.

2.5.2.2 Cross-over of source selection personnel (i.e., technical, financial and management) is imperative to evaluating proposals. The Arsenal Ship Program allowed industry to develop its own ship design. Because each Team's design, management and production approach differed, cost estimating had to be very individualized. The financial analysis team's results were very dependent on the findings of the technical team with regard to the design being proposed and the production methods utilized. Likewise, the management team's results were important to both the technical and financial teams' analysis. Insight into the findings of the financial and management teams provided the technical team further understanding of the proposal and potential risks. All source selection personnel were provided full access to all parts of the Industry Teams' proposals, including cost data. All source selection participants agreed that this full and open approach led to a greater understanding of what was being proposed, eliminated many questions and guessing, allowed for better identification of risks, and facilitated a true best-value decision.

2.5.2.3 Continuous interaction with Industry Teams throughout the design phases facilitated a short source selection schedule. The Phase I source selection for the Arsenal Ship Program was completed within three weeks from the time of receipt of proposals to the announcement of successful offerors. Phase I source selection criteriaís main focus was that offerors assemble a team fully capable of performing all aspects of the Arsenal Ship Program (i.e., trade-off analysis, design, construction, and support). Six proposals were received and five agreements were awarded. However, the Phase II source selection criteria required detailed analysis of each Teamís concept design in order to determine which represented best value to the Government. The Phase II source selection was completed within two months (Nov 15-Jan 11) from the time of receipt of proposals to the announcement of successful offerors. Given the large amount of information presented and the detailed analysis required, this schedule presented a

great challenge. The ASJPO believes this schedule was made possible due to the intense amount of interaction that occurred between the Teams and the ASJPO while industry was developing their concept design. Technical, cost and management approaches were continuously discussed prior to and during the Phase II and III periods of performance. As such, the ASJPO was provided great insight into what the Teamís proposal would contain. Risks were continuously assessed and discussed. Proposals presented by the Teams built upon work that had been presented throughout the year.

2.5.2.4 The ASJPOís ability to strictly adhere to schedules established at the onset of the program greatly enhanced program credibility and the commitment of the Industry Teams. In the Phase I Arsenal Ship Program Solicitation, the Government provided a top level program schedule addressing all phases of the program. This schedule indicated start/end dates for each phase and indicated release dates for solicitations, due dates for proposals and announcement dates of successful offerors for each phase. Every program milestone was met as originally scheduled for the eighteen months of Phases I and II. The ASJPO received tremendous feedback from the Industry Teams regarding its ability to establish a schedule up front and adhere to it. The Governmentís ability to manage its own portions of the program schedule facilitated the Industry Teams' ability to plan their own program schedule with Team members and subcontractors and execute accordingly without fear of delay on the part of the Government, which is all too typical in the majority of Government programs.

2.6 Testing and Certification

2.6.1 Background

Early in the Arsenal Ship program, the program office decided to pursue substitute methods for the traditional processes of test and evaluation and ship acceptance. As a consequence, provisions were included in the Phase II solicitation that required the Industry Teams to develop processes and procedures by which the Arsenal Ship Demonstrator and the Production Arsenal Ship would be certified as "fit and safe for the intended service." The purpose of this part of the Arsenal Ship "experiment" was to define and implement a streamlined process that would achieve the intent of Navy T&E and INSURV at less cost and in less time.

The Arsenal Ship Program Agreement required the Industry Team to provide the Government a Preliminary Certification at the end of Phase III. The Preliminary Certification signaled the end of Phase III and the readiness of the Demonstrator to proceed into Phase IV, Demonstration. A Final Certification report was also required of the Team. This report was to detail the test and evaluation results of the Phase IV Demonstration; define the capabilities of the Demonstrator, and verify the military utility of the Arsenal Ship. Receipt of the Final Certification Report signified the completion of Phase IV. The Government would accept the Demonstrator upon receipt of the final report or upon completion of deficiencies whichever was later.

ASJPO placed responsibility on Industry to identify and analyze the constituent elements of the current Navy test & evaluation and acceptance process and find acceptable alternatives that reduce time and cost. One cost reduction strategy was to reduce redundancy in tests and inspections. Self certification, as an example, is one way to do that. By the end of Phase II each Team had developed a plan and a proposed program by which they would "certify" both the Demonstrator and the Production Arsenal Ships.

2.6.2 Lessons Learned

2.6.2.1 An alternative to the traditional T&E and Acceptance process is possible as part of ship acquisition and that process can result in less cost and time without compromising safety, reliability, or performance. The work completed by the three Industry Teams, including preparation of a Demonstrator Test Plan, and a plan for Certification by the end of Phase II work, supports this conclusion. Inherent in the meaning of "certification" as "fit and safe for intended service" is a process by which all tests, analyses, inspections, etc. essential to verification that specific performance and safety requirements are met, are identified and completed. This then requires the Industry Team to establish traceability among all performance/safety requirements and the certification events necessary for their verification.

2.6.2.2 Some certifications are best performed by Government bodies. Certain certifications currently performed by Government activities, e.g., weapons safety by WSESRB, were deemed essential and had no acceptable alternatives. Other certifications, e.g., that for helicopters, were reviewed with an eye to change in order to improve performance. In the latter case, the rule

makers were willing to make changes as long as safety principles were retained. There was mutual agreement between ASJPO and the Industry Teams that these special cases would be incorporated into each Team's certification plan.

2.6.2.3 Certain unique range and test capabilities are owned by the Government (e.g., Eglin and Point Mugu missile test ranges) and it makes no sense to invest in any new facilities or replicate existing capabilities. DoD policy is supportive of industry use of Government ranges. Industry Team interaction and discussions with managers of various Government test facilities were positive and indicated that industry could avail themselves of these facilities in cooperative arrangements with Government. At facilities that are not unique, range managers will be challenged to control costs in order to remain competitive.

2.6.2.4 Classification Societies represent a resource to provide some cost effective inspections, analyses and commercial certifications. Classification Societies such as the American Bureau of Shipping (ABS) can perform certain hull and mechanical system certifications but do not have the background, experience nor the personnel to address uniquely military systems such as combat systems. ABS has developed a proposed Certification plan, which identifies by SWBS group, systems to be certified, appropriate standards to be applied, and recommended certification agents. The ABS work lends confidence to a movement towards commercial certifications.

2.6.2.5 Early involvement by Navy T&E activities in Industry-led IPTs is desirable. Currently, operational ship test planning expertise and knowledge resides in the Government and most range testing done for ships has been coordinated by military and Government civilians; therefore, these individuals can bring a wealth of information to the design and development process. This has to be controlled by the program office to insure that inefficient methods and procedures are not perpetuated and that the Government interaction has value added to the Industry Teams. The role of COMOPTEVFOR in demonstrations designed to support production decisions should be determined early in the program. OPTEVFOR participation is not essential to execute an effective program; however, their participation in Industry Team-led IPTs will bring operational credibility and experience to the process.

2.6.2.6 The issue of Live Fire Test (LFT&E) requirements and how they are handled within an Industry Team-led environment needs to be addressed. Arsenal Ship as a non-ACAT program was a special case not bound by LFT&E legislation. Other programs subject to this legislation will have to address the best mechanism to satisfy this requirement. In particular, some of the current requirements to perform vulnerability assessments, which could dictate design choices, may run counter to unconstrained performance trade space.

2.6.2.7 Some Government furnished items may be appropriate in the context of operational test and evaluation and demonstrations. Future ship acquisition programs will likely strive to minimize Government furnished equipment(GFE); however, the Navy should supply military or other unique, Government-owned items directly to the Industry Team if that is cost effective and facilitates meeting schedule milestones. Examples include missiles and other ordnance for demonstrations that may not be easily obtained by an Industry Team.

2.6.2.8 Ship Designation, "public" or "private," determines the applicability of U.S. Coast Guard and other international regulations. An early determination needs to be made whether a ship is a public or private vessel. Private vessels must comply with U.S.C.G. regulations. 46 USCA 2109 exempts public vessels from these same regulations. U.S. Coast Guard jurisdiction is determined by ownership and ownership in turn implies indemnification and liability. For Navy Ships, DoD (Navy) initiates a waiver of compliance for all life saving, navigation, and other regulations. Regulations for carrying/packaging hazardous materials are handled by a different organization within the Department of Transportation called the Research and Special Projects Administration (RESPA).

2.6.2.9 Early establishment of Industry T&E IPTs and Government participation in them is important. Active Government participation in Arsenal Ship T&E IPTs proved to be very beneficial and an effective way to introduce Government input and thinking into the Industry test and certification process. Early involvement of T&E personnel on other IPTs and in the design development process is essential, particularly when testing is part of a risk reduction program. Risk reduction tests and demonstrations need to be tracked and monitored at the Program office level.

2.6.2.10 User participation and Fleet Exercise planning in Industry tests and demonstrations should be coordinated by the program office. The Government program office should arrange for the availability and participation of active duty military and Government civilian personnel to support T&E and demonstration activities. The program office should also coordinate ship participation in fleet exercises.

2.7 Office Operations

2.7.1 Background

2.7.1.1 Organization

A small program office was an essential element of the ASJPO acquisition reform approach. A large number of people would have had a stifling affect on industryís innovation just from the sheer magnitude of opinions that would be expressed by such a group and industryís intense desire to please its customers. The make up of the office dictated by the original Memorandum of Agreement of 28 May 1996 among DARPA, ASN(RDA) and N86 specified six Government employees, growing to a maximum of 9 during Phase III. DARPA, NAVSEA, and ONR were to ìcontributeî (long term loan) 3 persons each, thus no billets beyond that for the Program Manager at DARPA were created for the program office.

Additional private industry personnel were collocated in the Program Office and dedicated full time. The companies, Vail Research and Technology Corporation and SYNTEK Inc., were barred from any contractual relationship with the competing Arsenal Ship Industry Teams. This approach is very much in keeping with past DARPA program office structures.

The total on-site staff by early Phase II (spring 1997) was as follows:

Program Manager	Capt. Charles Hamilton	DARPA
Contracts Negotiator	Cindy Shaver	NAVSEA (02)
Technical Director	Kit Ryan	NAVSEA (03)
C4I Engineer	Jack Frink	ONR (IPA from JHU/APL)
Combat Systems Eng.	Terry Sheehan	NSWC/Dahlgren
Survivability Engineer	John Grizzard	ONR
Admin assistance	8 people	Vail Research and Technology Corp.
Technical assistance	6 people	SYNTEK
Total on-site	20 people	

Significant off-site staff support was provided by:

General Counsel	Rick Dunn	DARPA
Assistant General Counsel	Dianne Sidebottom	DARPA
Contracts Management Directorate	John Ablard	DARPA

Support personnel were fully representative of the program office to the Industry Teams and to other Government activities; close integration of the support contractor team with the Government Program Office while avoiding personal services and inherently governmental function issues proved possible through open and continuous communication and clear understanding of roles. The support team consisted of:

Hull, Mechanical Electrical Engineer	Robert Percival	SYNTEK
Ship Operations and Support Eng.	Dr. Bob Johnson	SYNTEK
Systems Engineer	Ron Kiss	SYNTEK
Test and Certification Engineer	Jack Turner	SYNTEK
Operational Effectiveness Engineer	Bruce Dyer	SYNTEK
C4I Supporting Engineer	Mike Yermakov	SYNTEK
Ship Cost Engineer	Dave Schwiering	Vail
Office Manager	Jennifer Bennett	Vail
Financial Manager	Jennifer Sowa	Vail
Security Manager	Jim Booth	Vail
Computer Manager	Jack Stevens	Vail
Graphic Artist	Jill Judge	Vail
Administrative/Contracts Assistant	Wendy Turner	Vail
Travel Assistant/Receptionist	Frances Horner	Vail

2.7.1.2 Information and document control

On-site capability for handling documents through the Secret level was maintained. Front door access required a special access badge issued by DARPA. Only the above on-site personnel were issued these badges.

An acknowledged special access compartment was established to handle compartmented data at a site close by which was already functioning for this purpose. This greatly facilitated handling such data, discussions and even travel arrangements.

A classification guide was developed with the objective of making design information easily available to designers and production people for the life of the program. Thus, ship lines were made FOUO, for example. Even so, some of the Industry Team personnel were inadequately cleared in advance for sensitive data, which hindered Team communication and, sometimes, decision making. Structural design and signature analysis (and their effect on ship systems engineering) suffered from some of these restrictions on personnel.

2.7.1.3 Communication via IPDE

The goal of keeping in close contact with the technical progress of the Industry Teams necessitated regular communications. In addition to calls, email, and normal deliverables (which were few), numerous informal meetings were held on specific topics with individual Teams. While few in number during Phase I (perhaps 1 per month on each topic), these mushroomed into perhaps 1 per week on each topic during Phase II. It was hoped that use of an internet-based

engineering database system would enable much of this activity to take place without travel, but this did not turn out to be the case. A combination of travel and IPDE monitoring provided adequate insight.

2.7.2 Lessons Learned

2.7.2.1 Integrated Product Design Environment (IPDE) requires a cooperative collaborative effort between Government and Industry. The IPDE works best if all the users (including the Program Office) can make recommendations on security, software selection, modem speeds, and architecture/equipment needs. This should not be construed as an "automatic" at the initiation of a design effort.

2.7.2.2 "Open orders" need to be issued to facilitate rapid response on travel. Meeting dates were in constant flux due to natural program dynamics of each Industry Team. ASJPO was constantly making last minute travel plans and changes to accommodate this. Near the end of Phase II, DARPA instituted new travel rules that required more lead time than was available for many of these meetings. To be responsive, open orders, with limitations, would greatly ease the administrative burden on the travel system. In addition, a portion of travel funding should be left at the parent organizations to expedite the travel process for those outside the Program Office.

2.7.2.3 Extensive ASJPO use of email for internal communications worked well. Portable computers allowed online access while on travel and during off-hours. A secure ASJPO Web Page and encrypted e-mail capability for source-sensitive materials would have improved the process. Secure video teleconferencing capability was underutilized but recommended for future efforts.

3.0 TECHNICAL

3.1 Systems Engineering

3.1.1 Background

The Arsenal Ship Program Office, recognizing the complexity of the ship being developed as well as the challenging schedule established to complete the design and construction, expected the Industry Teams to rely heavily on a systems engineering approach. A key aspect of this program was the decision by the Government to turn the systems development process over to industry from the earliest stages of the process. This decision challenged industry to develop and design the optimum mix of performance capabilities within the production and life cycle cost affordability constraints.

Related to the application of the systems engineering approach were the use of an Integrated Product Development Environment (IPDE) and Integrated Product Teams (IPT).

Critical drivers of the process were the use of Price As Established (PAE) and the extremely low manning goal established for the ship. The low cost goal established for the Demonstrator ship, compelled the Teams to focus on major system engineering objectives and tradeoffs.

3.1.2 Lessons Learned

3.1.2.1 A systems engineering approach is essential. A disciplined systems engineering process based on defined goals, thresholds and trade space is essential. It creates the environment for true innovation, and enables industry to solve the complex design problems associated with the MFSD. Providing industry with unprecedented freedom to develop their own solution to a ship design without the application of Systems Engineering would not likely yield a successful outcome. Systems engineering in and of itself was no guarantee that the "best" solution was derived, but its discipline helped the program management understand better whether the approach was complete, and whether the right priorities were assigned and the right questions asked.

3.1.2.2 Adequate time is needed for Industry Team formation and growth. Much energy was spent by industry in the first two months of Phase I sorting out Team membership and Team relationships. At the start of Phase II, the average Team size increased from about 50 to over 200 people in a short time frame, which caused different design maturation rates among the Teams. The phases of the program were structured to allow seamless transition from one phase to the next. Industry did not take full advantage of the downselect decision period to position themselves for the next phase. Had they done so, the Phase transition would have been much

smoother. Without this, an additional 2 months for Phase II would have permitted all three consortia to fully mature their functional design.

3.1.2.3 An Integrated Product Development Environment (IPDE) and Integrated Process Teams (IPT's) were beneficial to design success. IPDE and IPT's contributed in very powerful ways to expedite the process and to ensure that the process did not neglect any critical aspects of the design. In one Teams case, the IPDE allowed geographically dispersed members of the Team and the Government to work with the most current information available at all times. This was essential to permitting the level of concurrency necessary to meet their constrained schedule. The IPDE also facilitated the ability to move quickly from stage to stage in the design evolution. The Team that excelled in using IPDE tended to make faster progress because information transfer among Team members occurred at a more rapid rate. Similarly the IPT's ensured that interdisciplinary teams were focused on the most critical parts of the overall design problems and that complete solutions were considered. To ensure that the IPT's themselves did not become "stove-piped", collocation, cross membership of key individuals and the IPDE were utilized.

3.1.2.4 Freedom to make trades enabled achievement of cost and schedule goals. Giving Teams nearly infinite flexibility to make trades enabled them to achieve low cost goals and schedule constraints. The Teams reinvented the sequence of steps in the ship design and construction process to meet the cost and schedule goals of the program. Certain subsystems were eliminated because their lead times would not meet the schedule.

3.1.2.5 A design competition performed by industry may be an acceptable substitute for a Government run COEA/AOA. A PAE-based program trades cost, performance, and schedule. The competitive Industry Teams had the freedom to seek the "best value" solution. Competing Industry designs effectively encompassed the range of real solutions to the CONOPS. Not only were they varied in size and capability, but the solutions were also realistic, in that they were actually procurable. This contrasts with typical Government conducted COEA studies that identify hypothetical solutions that are not validated, particularly with respect to cost or producibility.

3.1.2.6 Industry Team control of the full trade-space is essential to achieving total ship integration within the PAE goals. Previously unthinkable trades crossing many boundaries, such as trading propulsion capability for lines of code in the communications suite were discussed. In Arsenal Ship, the PAE process forced significant innovation: three new launchers; improved software processes; COTS insertion and refresh, and software reuse are some examples. Through industry IPTs, a total ship engineering approach was applied for a balanced hull and topside design, trading off signatures, communications systems, navigation systems, weapons and cost.

3.1.2.7 Industry Teams are fully capable of producing new combatant ship designs. The design products delivered over the course of the program were excellent, and comparable in overall quality to previous in-house Navy designs. Industry was extremely effective in assembling

a mix of private and public sources, marine and aerospace, to cover the full range of technical disciplines.

3.1.2.8 Design commercialization requires new systems architecture not only for information systems, but also for mechanical systems, to permit use of COTS systems and equipment. One of the best examples of this innovative thinking involved methods of shock mitigation for selected equipment. It was obvious that militarizing all equipment would have eliminated the opportunity to use commercial-off-the-shelf items. By focusing on shock isolation schemes a more cost effective approach was achieved.

3.1.2.9 Early application of budgets for cost and performance was essential. Budget and performance allocations to established goals and thresholds are facilitated by the discipline inherent in the system engineering process. The teams who were most successful at setting cost and performance budgets and sticking to them became the most competitive.

3.2 Survivability

3.2.1 Background

The survivability of the Arsenal Ship was broken into three categories: susceptibility, vulnerability, and recoverability. Susceptibility was defined as the probability of the ship being detected, targeted, engaged and hit by a threat weapon. Vulnerability was defined as the probability of the ship being damaged to the point of losing mission capability, propulsion, or being sunk. Recoverability was defined as the capability of performing fire fighting, damage control, and recovering mission capabilities after incurring damage from a threat attack. Recovering mission capability (= "fighting hurt") was not a program goal. These definitions were given to all Industry Teams early in Phase I as a guide to how the ASJPO was to analyze and evaluate Industry designs.

Since the Industry Team was responsible for the ship design, the ASJPO did not define a specific set of threats through a System Threat Assessment Report (STAR). Instead, the ASJPO provided references and sources for threat information within the Defense Intelligence Agency (DIA), Office of Naval Intelligence (ONI), and NAVSEA. Each Industry Team was then allowed to request threat information directly from these sources. In many cases, the ASJPO helped facilitate the transmission of threat information to the Teams. None of the Teams asked for an identical set of information, however, the threat assessments provided similar results. The top level design goals for each Team, derived from these threat assessments, were not drastically different; however the approaches taken in the ship designs to achieve these goals were drastically different and showed unique and innovative solutions.

In addition, the Teams were provided with points of contact for Government ship survivability expertise. The Industry Teams were provided an opportunity to contract directly with Government R&D Centers to hire Government experts and to take advantage of Government computer models and simulation tools. In the survivability area, most of this activity occurred between industry and NSWC Carderock for weapon effects analysis and design. In Phase I the Teams were only allowed to contract for "objective services". The NSWC engineers were allowed to provide lessons learned from previous work and provide computer analysis of industry designs. In Phase II, all three Industry Teams contracted with NSWC Carderock for exclusive IPT support for vulnerability reduction analysis and design. Personnel supporting the Industry Teams in Phase II were "fire-walled" from each other to prevent inadvertent release of competition sensitive information. A separate set of engineers at NSWC Carderock provided direct support to the ASJPO. The management of personnel resources to allow NSWC Carderock to provide support to both industry and the ASJPO required up front planning and policy making.

The ASJPO Survivability Team included members from ONR, NAVSEA, NSWC Carderock Division, and System Planning Corporation (SETA support to DARPA/TTO). By the end of Phase I, and for Phase II Source Selection, the team consisted of seven people: The ASJPO Survivability Manager, one magnetic signature engineer, one electromagnetic (RCS/IR) signature engineer, two ship acoustic signature engineers, and two vulnerability engineers. After

Phase II Source Selection was complete, the team was increased to eleven with the addition of one electromagnetic signature engineer, two damage control/fire fighting engineers, and one composites/materials engineer. The team of eleven was maintained throughout Phase II and all would have participated in the Phase III Source Selection effort. With this diverse group, the ASJPO was able to review all aspects of industry's survivability designs, provide pertinent information on Navy ship survivability activity, and leverage off ship survivability research and development efforts throughout DoD. Because most of the team members simultaneously worked on other ship programs, lessons learned from other programs were easily transferred into the Arsenal Ship program.

One dilemma a program office faces when industry is given total responsibility is that analysis tools used can differ from one competitor to the next. Often there is no standard by which to calibrate these tools for comparison sake. In order to discount this problem, the ASJPO tasked several Government organizations to perform independent analysis of the three industry designs. The Naval Research Laboratory was tasked to perform RCS/IR signature predictions and run CRUISE MISSILE engagement simulations against expected threats. NSWC Dahlgren Division Coastal System Station, Panama City, FL was tasked to perform mine susceptibility studies using the Total Mine Simulation System (TMSS) and Naval Mine Warfare Simulation (NMWS) tools. NSWC Carderock Division was tasked to perform ship vulnerability analysis against projected warhead threats using the Ship Vulnerability Model (SVM). By using the same models to analyze all three ships, the ASJPO was able to obtain a fair comparison of ship performance that would have been used as part of the downselection process.

3.2.2 Process Lessons Learned

3.2.2.1 An integrated Survivability team and approach allows for an optimized design that provides improved ship survivability. By working all ship survivability aspects together, trade-offs and optimization can be achieved to provide a more survivable, cost effective design. By working the different survivability areas separately, complementary and optimized designs will most likely not be achieved, compromising ship survivability and affordability.

3.2.2.2 Ship vulnerability/weapons effects hardening expertise, technology development and analysis capability resides largely in the Navy R&D Centers. System design and integration capabilities are the Industry Team's area of expertise. Early involvement in the Functional Design Phase of the Navy R&D Centers working with the Industry Teams is vital. During Phase I, the ASJPO detected a weakness in the structural survivability area on all five Industry Teams. Industry has never had motivation to develop ship vulnerability/weapons effects design expertise as an in-house capability. Early in Phase II, the ASJPO, in conjunction with NSWC Carderock, conducted a survivability course for the three Phase II Teams. This course allowed the Government to share Navy ship survivability methodologies, technologies, and lessons learned. All three Teams used the information, as well as NSWC Carderock on their IPT's, to improve their ship designs.

3.2.2.3 In the case of signature control and damage control, technology exists to achieve the signature and automation levels desired. However, cost-effective designs and large-scale demonstrations are needed to prove the concepts. Without large-scale demonstrations, technologies will go from the R&D Center straight to a ship without sufficient development, causing high risk and costly implementations. The Arsenal Ship Demonstrator, or Maritime Fire Support Demonstrator, would have provided the Government and Industry an opportunity to show at a large-scale that affordable signature control and automated damage control/fire fighting are technically feasible. The demonstrator ship would have allowed for advanced concepts to be implemented and tested, ultimately providing low risk, cost effective solutions to future ship programs. Without these engineering and demonstration efforts, future ship programs will continue to implement stove-piped, costly, and inferior systems.

3.2.2.4 In order to transition Government developed technologies to an industry lead design effort, a program office must identify pertinent technologies and communicate their availability to the Industry Teams. The three Industry Teams were very receptive to Government R&D efforts and used a variety of recently developed Navy technologies in their designs. Throughout Phases I & II, the ASJPO Survivability Team briefed the Industry Teams on a variety of technology programs and developments including the Integrated Magazine Protection System and surface ship acoustical tiles. The Teams used the information provided by ASJPO to enhance their designs.

3.2.2.5 The Industry design teams favored components and/or subsystems that were already developed or whose development was being funded by the Government. If a technology or system development was being funded by the Government, the Industry Teams would, in most cases, include those in their design instead of incurring the expense of internal development. This is important in answering the question of how to integrate Government developed systems into designs totally controlled by industry. The answer is, "It happens naturally because the Industry Teams do not want to add unnecessary cost to their system, especially during a competition."

3.2.2.6 It is important for key industry participants to have appropriate security clearances and access to information early in the mission analysis/concept design process. During Phase I and the early stages of Phase II, many industry personnel, especially in the shipyards, did not have Top Secret clearances. Much of the data and analysis regarding ship susceptibility is held at that security level. Because of the mismatch, many key personnel were not privy to some of the trade studies and design goals. This caused requirements flow-down without being able to communicate requirements justification. In some cases, requirements were derived without being able to execute the appropriate trade studies and analysis.

3.2.3 Product Lessons Learned

3.2.3.1 Defining a realistic program goal at a top level (e.g., passive survivability through use of signature control) and giving industry the freedom and resources to choose the approach and achieve the goal, will provide products that meet or exceed performance goals and cost goals. Given a top level goal, freedom to use industry developed technologies and processes, and reasonable program resources (time and money), industry can conceive, design,

and produce product solutions faster, cheaper, and better than internal Government led design teams.

3.2.3.2 It is imperative that the Government, in executing a source selection, be able to compare the ship designs and performance characteristics using a common set of analysis tools. With multiple Industry Teams doing ship design, a variety of design, modeling, and simulation tools are used. Some of these tools have been validated against test data, some have not. In order to provide a common analysis environment, the ASJPO tasked NRL, NSWC/DD CSS, NSWC/CD, and NAWC-WD Pt Mugu to do analysis of the three ship designs independent of the Industry Teams. This enabled the ASJPO Source Selection Group to do comparisons of the three ships with common analysis tools.

3.2.3.3 The fidelity of inputs available for independent Government evaluation varied between designs. Because of the varied design approaches and maturity levels, the information available to the ASJPO for on-going evaluation and source selection were not equal from all the Teams. The ASJPO had to develop analysis approaches which normalized the fidelity of the designs for its analysis effort.

3.3 Combat System/Command, Control, Communications, Computers and Intelligence (CS/C4I)

3.3.1 Background

ASJPO CS/C4I objectives during these two phases were: to understand each Industry Teamís Combat System and Command, Control, Communications, Computers, and Intelligence concept; evaluate it; rank each concept relative to the Arsenal Ship CONOPS; and assess its performance relative to Arsenal Ship Missions and consistency with the DoD C4I Vision. An additional ASJPO objective was to facilitate interaction and coordination among Government organizations and between the Teams and Government organizations to maximize each Team's potential for developing a successful CS/C4I functional design

Responsibility for requirements derivation and system engineering structure and development of a Functional Design resided with the Industry Teams. ASJPO provided a top level CONOPS and Ship Characteristics Document (SCD) as the basis for Industry to derive CS/C4I performance requirements. As such, ASJPO adopted an oversight philosophy based on an interactive and supportive approach on a minimally invasive basis during reviews, technical interchange meetings, and internal meetings with each Industry Team.

3.3.2 Organization

Figure 3-1 presents the ASJPO CS/C4I Assessment Team (CCAT) structure which consisted of a Core Team supported by advisors in CS/C4I functional areas. The Core Team itself is part of ASJPO and served not only to integrate analysis and assessments of CS/C4I functions, depicted at the bottom of the pyramid, but also to integrate those products with other functional areas (HM&E, T&E, Risk, Cost, etc.) to support an overall assessment of each Industry Team's Arsenal Ship design.

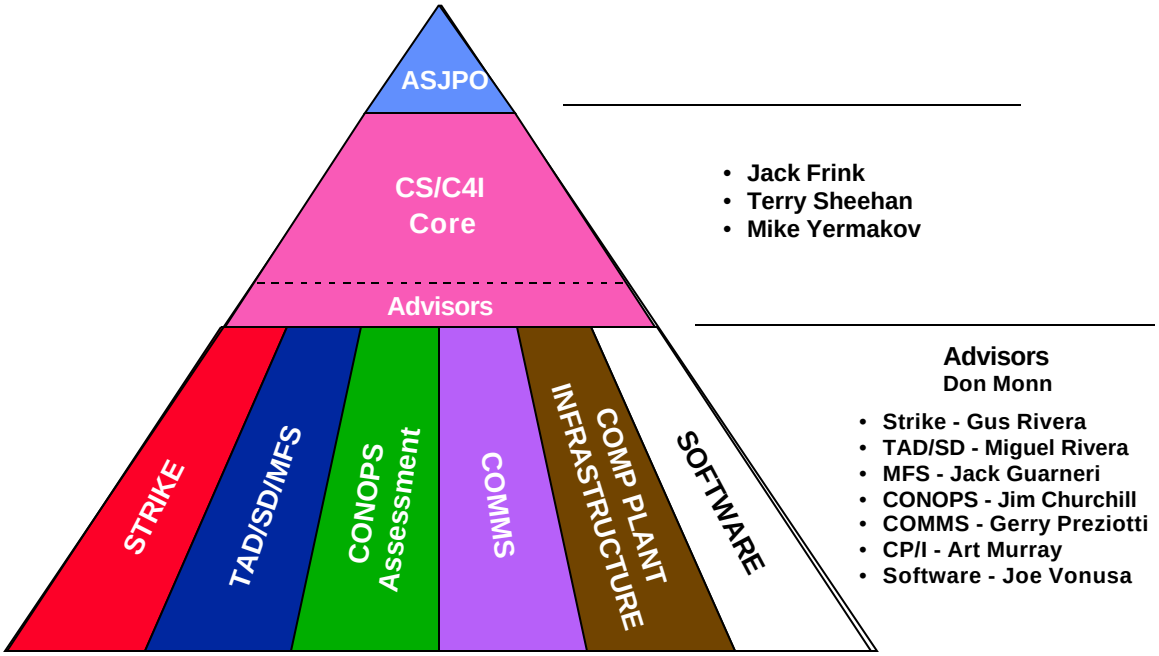


Figure 3-1. CCAT Structure

The CCAT Core Team attended all program reviews and encouraged consideration of out-of-the-box opportunities for technology insertion and business practice reform. Additionally, the Core Team provided the interface with other functional design areas (e.g., HM&E) within the ASJPO.

The organizations provided about 10 technical advisors to the ASJPO CCAT are shown in Table 3-1. They received documents and attended two meetings with each Industry Team related to CS/C4I to gain understanding of the requirements, concepts, and functional trade-offs studies that led to CS/C4I design baselines.

Table 3-1. CCAT

ASJPO
SSC-SD (formerly NRaD)
NSWC/DD
JHU/APL
SYNTEK
WEPTAC (China Lake)
NSWC/PHD/ECO
SPC

ASJPO encouraged direct Industry liaison with Government program offices developing or responsible for systems that the Teams wished to integrate or consider as part of their design. However, ASJPO was a facilitator for interaction when required.

3.3.3 ASJPO/Government Interactions

Because all the Industry Team concept proposals resulting from Phase I had impact on off-board systems that would require both resource and schedule coordination within the Government, an Arsenal Ship Off-board Systems (ASOS) working group (Table 3-2) was established.

The ASOS provided a forum for exchanging information between Government organizations on both technical and programmatic issues. For example, system baseline descriptions including funding and schedule profiles were presented. The ASOS also provided a mechanism for negotiating policies for interaction between a represented activity/program, ASJPO, and Arsenal Ship Teams.

Program/Activity	Resource Provider
Arsenal Ship	ASJPO
AEGIS	PEO-SC/AP
ATWCS	PMA-282
AFATDS	PM-FATDS (Army)
JMCIS/JMCOMS	SPAWAR
CEC	PEO-TAD/C
ATACMS	SSPO
NSFS	PMS-429

Table 3-2. Arsenal Ship Off-board Systems Working Group

Communications between CCAT members working at R&D Centers, etc. were open. However, communications of industry related business-sensitive information was strictly controlled. Additionally, advisors supporting the Core Team were limited to interaction on a strictly technical basis and as a rule attended only ASJPO-scheduled Industry meetings. Additionally, ASJPO limited access to Industry Team IPDEs to the Core Team.

3.3.4 Government C4I Assessment Activities.

The work effort to support CS/C4I was structured into two general work task assignments: Warfighting Assessments; and Technical Assessments.

- The warfighting assessments consisted of a CONOPS review in the context of scenarios in both simulated and seminar style wargames. Feedback from cross service operators was obtained on viability and impact to current and evolving doctrine/tactics. Industry Teams were encouraged to participate in the process to improve their designs by integrating operator input into their design process.

- The technical assessments were focused on traceability of industry-derived (based on the Government's CONOPS and SCD) requirements to the CS/C4I concept and functional design and a "best-value" analysis of the designs. The CS/C4I architectures were broken down into four main elements: mission; communications; support infrastructure; and software. Each element was assessed for feasibility, dependence on other programs, and impact on off-board systems or effect on infrastructure (as in the case with various COMM architectures). Additionally, an assessment based on broad-based DoD Joint Operations goals, such as Joint Vision 2010, Concept for Future Joint Operations, and Netted Targeting was conducted.

For each Industry Team, a system block diagram and functional requirements trace was captured and updated periodically as the Teams' designs matured. Additionally, associated technical and development schedule data was captured (when available) and maintained to keep the CCAT informed of progress toward Phase II deliverables.

3.3.5 General Lessons Learned

3.3.5.1 Core Team interactions with Industry stretched their decision space. By questioning old approaches, suggesting new ways enabled by technology, and challenging the Industry Teams to find innovative and creative solutions, ASJPO increased the range of design options considered.

3.3.5.2 The notion of availability of Government legacy system information, expertise, and software to competitive Teams was not universally accepted. Some program offices, Government R&D Centers and UARCs delayed or refused access to information and software. Specifically, issues of control, future development agent, and configuration management were surfaced. This is a serious issue for Industry led acquisition programs that will need resolution in the future.

3.3.6 CONOPS Assessment

In keeping with the goals and objectives of Joint Vision 2010, Warfighters across DoD were integrated into the assessment process through a series of seminar and simulated wargames. The wargaming activity brought together ASJPO, Industry Teams, and Joint Service representations into a structured and "competition secure setting" to understand and evolve industry's concepts based on user assessments and feedback. It addition, it provided a mechanism for ASJPO to identify those factors the warfighters considered important to rank the industry designs. The active duty participants were generally at the O4 - O5 level and their insights and vision were beneficial to each of the Teams as well as to ASJPO.

3.3.6.1 CONOPS Assessment Process Description

The Weapons and Tactics (WEPTAC) Facility at China Lake, California was selected as the site for the wargames. Its remote location allowed the participants to focus with minimal interruptions.

Three basic tactical scenarios were developed to exercise the Arsenal Ship designs and programmed into the resident computer-assisted gaming facility. Each participant was assigned an operational command role and located in a closed game room where appropriate displays, information and communications channels were available to conduct operations. For the first games, each Industry Team had a day to explain their Concept of Operations, advise the participants on how to fight their Arsenal Ship concept, observe the games, and collect feedback from the participants. At the end of each day, and at the end of the week, Government-only sessions were held to discuss the results and collect feedback from the participants. Each scenario was played in a separate week over the summer.

A final Government-only week consisting of open seminar discussions of specific issues and comparisons of the Teamsí approaches was held.

3.3.6.2 CONOPS Lessons Learned

3.3.6.2.1 Involving Joint warfighters in exercising the Operational Concepts of the Teams was very positive for the Teams and for ASJPO. Exercising each Industry approach in a wargame environment provided immediate feedback to the Team as to military utility, impact on current and future doctrine and employment methods, and helped them to refine their concepts. Interaction among the operators from three services was important to get a Joint perspective. ASJPO got comparative feedback from the warfighters on the approaches. Another benefit occurred when operators returned to their duty stations able to address both the pros and cons of the Arsenal Ship concept.

3.3.6.2.2 The Government only seminar game at the end of the process provided the most feedback to ASJPO. Candid discussions and comparisons of approaches by the warfighters could be made only when no Industry Team members were present. Early games were valuable to provide feedback to the Teams and to train the participants on the approaches.

3.3.6.2.3 There is a need for improved capability to assess and contrast future warfighting concepts. The CONOPS assessment process highlighted the need for future improvements, such as: real-time gaming, higher fidelity simulations and live system participation. The Joint and Maritime Battle Centers should be included in the future.

3.3.6.2.4 All the Teams demonstrated the ability to invent new ways of conducting warfare that are operationally meaningful. The Industry Teams conducted effective mission area analysis to support CONOPS development and requirements generation. New command structures and organizational relationships were considered, including Joint Vision 2010 and warfighting experiments. The Arsenal Ship vertical gun for advanced ships (VGAS) element was heavily used to support ground fires.

3.3.6.2.5 Flexibility of operational employment was valued by the warfighter. Designs that enabled the operation commander to use Arsenal Ship in creative ways were valued by the warfighters. In particular, they wanted to maximize the design flexibility of the existing (or planned) C4I architecture to be able to reconfigure the connectivity as needed. A primary utility

of Arsenal Ship proved to be early massed precision firepower for both invasion stopping and anti-SEAD prior to arrival of traditional forces.

3.3.6.2.6 The Sensor-to-Shooter concept was accepted and excursions with JSTARS were particularly effective. Direct targeting, especially from JSTARS, was found to be effective in calling in Precision Guided Munitions (PGM) and calls for fire. Joint real-time battle management, including en-route and target area airspace deconfliction, was identified as a critical need as rapid response weapons become deployed in the same volume as air and ground forces.

3.3.6.2.7 New types of precision weapons, seekers, and warheads were desired by operators. With 500 Arsenal Ship VLS cells available on short notice the warfighters wanted more types, and lower cost ordnance for the cells.

3.3.6.2.8 Warfighters prefer the opportunity to apportion assets to any echelon or force level necessary to conduct the mission. Arsenal Ships could be considered floating magazines with missiles belonging directly to the force to which they are apportioned. A common weapon control and communications network is required to respond to fire calls at any echelon apportioned weapon control authority. This approach is desired for any missile ship supporting land attack missions.

3.3.6.2.9 The Joint forces need to review the responsibilities for weapon control and launch authorization under "network centric" warfare concepts. Remote trigger raised concern about the responsibility for launch authorization. Traditionally, responsibility resides with the ship's commanding officer; however, when weapons are allocated to off-board control nodes the responsibility for safe use of the weapons must be allocated off-board.

3.3.6.2.10 The warfighters preferred a ship that can operate with minimum dependence on other ships in order to minimize disruption to their missions. Collaborative self defense was accepted but routine dependence on off-board assets was viewed as invasive. However, the availability of Arsenal Ship with large numbers of Land Attack missiles afforded the opportunity to load the AEGIS ships with more cruise missile defense missiles.

3.3.6.2.11 Warfighters were interested in the ability to rapidly fire missiles in order to minimize time exposed to enemy fire. While exploring different employment concepts for the Arsenal Ship, the warfighters concluded that they wanted to minimize the time to launch for the entire mission since the ship was hard to hide while firing (flaming datum).

3.3.6.2.12 Warfighters and engineers are concerned with security as the Navy moves to "Network Centric" operations. With the delegation of weapons release authority to off-board systems, protection requirements against information warfare and inadvertent launch become more stringent.

3.3.6.2.13 Initial skepticism about the efficacy of the Arsenal Ship concept changed as the games progressed. In particular, as details of the passive self defense capabilities were included in the conduct of the games, more tactical employment options were tried with success.

3.3.7 Mission Areas (TAD, STRIKE, MFS) and Combat Systems

3.3.7.1 Process Description

The mission element assessed how each Team approached and met the requirements derived in each mission area (TAD/Strike/MFS). This assessment included feasibility, dependence on other programs, and impact on off-board systems. NSWC/DD was tasked to provide an assessment of Industry designs in TAD and Strike missions. Both JHU/APL and NSWC/DD provided an assessment of the Teams' MFS functional designs.

NSWC/DD, JHU/APL, and SPC were tasked to develop and maintain a functional requirements trace, system block diagram and message flow diagram for each Industry Team's design. Design impact to Off-Board systems were studied to understand and develop a basis for assessing the cost and feasibility for launch of SM-2, Tomahawk and ATACMS.

3.3.7.2 Mission Area Lessons Learned

3.3.7.2.1 The ASOS was an effective group for sharing programmatic information among Government offices involved with the Arsenal Ship project. In general, the working members of ASOS had senior technical responsibility for their respective projects and were interested in finding workable solutions to issues of integration with Arsenal Ship. The discussions and information exchanged had benefit beyond the Arsenal Ship since it fostered a collaborative working relationship for issue resolution, including for example, between individual Program Offices which had no other communication mechanism.

3.3.7.2.2 The ASOS dialogue suggested ideas shared development costs and identified opportunities for implementing new capability in the fleet. The Arsenal Ship Industry Teams were prepared to upgrade Tomahawk Weapon Control System Software to automate functions. This software could be applied in other surface combatants as well, which could effectively reduce manning on those ships. As another example, the Arsenal Ship program and Special Projects Office planned on combining efforts to accelerate introduction of ATACMS capability into the Navy. SPO planned to integrate the missile into VLS and Arsenal Ship planned to develop the weapon /launch control systems.

3.3.7.2.3 The Teams selected system designs based on cost and performance rather than on internal Government program pressures. The Teams universally endorsed the Army's AFATDS system on Arsenal Ship rather than pursuing the in-house Navy LAWS system.

3.3.7.2.4 Some PARMs were reluctant to work with three Industry Teams. Several of the PARMs deferred serious consideration of Industry Team designs and implications for their system development until Arsenal Ship downselected to one developer.

3.3.7.2.5 ASJPO sponsored feasibility studies at the R&D Centers assisted in identifying the off-board system impacts resulting from Arsenal Ship system concepts. This information assisted in evaluation of Industry Team remote trigger concepts and ensured consequences to off-board systems were described and accounted for by the Teams.

3.3.7.2.6 Industry can determine the most effective use of legacy systems within their design concepts. Integration of legacy systems was accomplished by one of three general approaches:

1. The Team used the functionality and algorithms of an existing system but redesigned the software in an object-oriented environment using modern software languages (e.g., Standard Missile launch control).
2. Legacy Systems were integrated into the computing and control infrastructure with few changes by developing a "wrapper" around the system. This "wrapper" approach makes it easier to incorporate new baselines of legacy systems with minimal changes over the life of the ship. This approach simplifies configuration management, minimizes programmatic coupling, and is still able to capture future upgrades.
3. The Team chose not to utilize the legacy system and built their own because the available system did not support enough of the Arsenal Ship unique requirements. (e.g. integrated survivability control system).

3.3.7.2.7 Fire support deconfliction must be addressed at the Joint force level to ensure rapid and safe response to call-for-fire. Deconfliction is determined by allocated no-fly and no-fire zones rather than supporting real-time deconfliction decisions, which are necessary with the increase of sea-based long range fire support weapons.

3.3.7.2.8 The availability of large volumes of inexpensive ordnance remains a priority of the Army and Marine Corps. ATACMS launches are not currently considered available for call fires by USA and USMC. The Marines consider low cost weapons more accessible for direct and general fire support missions. There is a need for analysis to determine the overall cost effectiveness of massive amounts of inexpensive dumb ordnance versus smaller amounts of extremely expensive precision ordnance.

3.3.7.2.9 The operator can be taken out of the loop for weapon control systems. The issue still remains whether the technology is advanced enough to automate target selection, identification, and battle damage assessment functions, all of which were to be performed off-board Arsenal Ship. Command authority issues should never be automated but can be delegated to rapid response systems.

3.3.8 Communications

As an entity enabled by the Information Age, the Arsenal Ship relies on robust connectivity to obtain targeting, mission data and weapons release authority.

3.3.8.1 Process Description

Resources at System Planning Corporation (SPC), SPAWAR Systems Center, San Diego, (SSC-SD, formerly NRaD), and The Johns Hopkins Applied Physics Laboratory (JHU/APL) were tasked to track and technically assess the evolving communications designs for ASJPO. They developed common format block diagrams of the functional architecture, conducted engineering analyses, and identified technical and operational risk areas. One purpose was to understand the information flow, independent of the particular communications channel employed, from source to ultimate destination.

An effort was initiated at SSC-SD to configure their C4I R&D Centers to replicate the connectivity proposed by the Teams. This effort was terminated in August 1997 when it became apparent that the original objective to make quantitative measurements was not feasible this early in the design cycle.

ASJPO interactions with the Teams encouraged them to consider diversity of communications paths and an ability to accommodate future structures of Joint Force connectivity over the life of the ship.

3.3.8.2 Communications Lessons Learned

3.3.8.2.1 The rapidly changing connectivity designs made it difficult to replicate them in a R&D Center. The lead time to configure hardware sets, and computer models, made it difficult to replicate and assess the evolving connectivity designs. In addition, proposed new hardware elements and message types were not available. The process of asking detailed questions to support R&D Center testing of their concept, however, did encourage the Teams to become more specific in their designs.

3.3.8.2.2 Some design trades, such as new TADIL messages and formats, are outside the control of the Teams. Operational issues, such as availability of satellite communication bandwidth, modified or new TADIL message formats, and future JTIDS stacked net configurations were not under the control of the Teams. They made assumptions to support their connectivity concepts, which would have matured jointly in the following phases.

3.3.8.2.3 Many options exist for future joint connectivity to support Arsenal Ship-enabled distributed warfighting. No single unified approach to joint connectivity was found. The Teams produced approaches derived from their CONOPS which were consistent with todayís connectivity options and which could support projected ones. Communications path innovation was limited since onboard assets had to be compatible with offboard systems. It was in the automation of onboard assets and handling of data that opportunities for different approaches were found.

3.3.8.2.4 Industry has much more capability to quickly develop and field a total integrated system for communications. The Teams were effectively designing a Joint Maritime

Communications system without relying on the Navy for the components or software development. Industry has more freedom to select from a broader range of COTS, GOTS or new development systems than the services. There is less "stovepiping" of systems design due to the pressure to cut costs and improve overall performance.

3.3.8.2.5 Non-Conventional threats such as Information Warfare, conventional Electromagnetic Pulse (EMP), and High Power Microwave (HPM) were not highlighted. Distributed warfighting places increased reliance on availability and security of communications. Evaluation of the threat of unconventional means of disturbing the transfer of information should be undertaken.

3.3.9 Information Infrastructure

Large systems increasingly rely on Information Technology and are typically designed with an integrated, internal digital communications capability linking computers together into a collaborative distributed processing environment. This shared infrastructure was recognized as essential to the proper functioning of the Arsenal Ship.

3.3.9.1 Process Description

Perhaps here, more than the other areas, the Teams were encouraged, primarily by their internal PAE process, to adopt commercial practices and develop a design that embraced open system architectures. No formal assessment methodology was employed and normal reviews and design documents provided disclosure of their approaches.

In all cases, innovative and robust designs were proposed that fell into the mainstream of commercial computing practices and represented major increases in capability over present ships. Ubiquitous high speed integrated digital communications (voice, data, video) and general purpose redundant computer plants to support all electronic functions on the ship, including sensors for damage control and condition based maintenance, were designed.

3.3.9.2 Information Infrastructure Lessons Learned

3.3.9.2.1 Teams demonstrated a capability to adopt commercial open-architecture practices and adapt them to a ship design. Government open system standards such as DII/COE were acknowledged and selectively adopted but the main emphasis was on commercial open system approaches in areas of operating systems, networks, computer hardware, and protocols.

3.3.9.2.2 Multi-level security for integrated networks is an important issue. The traditional physical segregation technique for data at different security levels is incompatible with the basic philosophy of shared networks and has a major cost impact. This is an issue bigger than Arsenal Ship and new techniques, procedures, and regulations are needed and are being addressed by appropriate agencies.

3.3.9.2.3 Information System designs are scaleable and have the potential for reuse. Typically computer networks and distributed processing designs are scaleable either upwards or downwards.

3.3.10 Software Development Process

Computer software is an area of increasing concern and cost in large system development and integration. Studies by the Software Engineering Institute and others have concluded the development and support processes are critical to producing high quality computer programs.

3.3.10.1 Government Process Description

NSWC/PHD/ECO was tasked with reviewing and assessing the process of software development proposed by each Team. The Teams were each invited to host a meeting where they described their approach to a small set (4 or 5) of ASJPO advisors. Team attention was focused on understanding, rethinking, and refining their approach to software development in an environment without imposed Government process specifications. Process innovations were encouraged but not pushed.

Each of the Teams described their methodology for Arsenal Ship software development. They described their successes on past projects and process improvements proposed for AS. Internal software process audits, SEI ratings, and other relevant information were presented to convince ASJPO that their approach was credible.

3.3.10.2 Software Lessons Learned

3.3.10.2.1 The Government approach had the desired effect of highlighting the importance of software and its development process. The request for disclosure of software process spurred the Teams to focus attention on this area and consider commercial innovations. Specialists from the commercial software marketplace or SEI should be invited to participate as advisors in future competitions.

3.3.10.2.2 Relief from Military Standards permitted a more appropriate software development process. Industry Teams were allowed to rely on their own, proven software development methods, rather than be forced to apply rigid Mil Standards, such as 1679A, 2167A, 498, etc. Most took a modified 498 approach that retains control while not overburdening the development process. A demonstrated development process plus having controls and metrics to ensure tracking, consistency and quality are the critical components. With commercial certification at SEI level 3 or higher, Industry Teams are very capable of governing their own software process.

3.4 Ship Hull, Mechanical and Electrical Design (HM&E) & Ship Production

3.4.1 Background

Each of the competing design teams used a slightly different philosophy but all were similar in their motivation to satisfy both the requirements and the cost goals at the highest performance level. Survivability and mission capability of carrying and remotely launching 500 missiles dictated the HM&E design.

Each Team's HM&E design reflected the experience of the shipyard that was a member of the Team. Overall, the hull design starting point was from another program or typical of the shipyard's product line (e.g., commercial ship, aircraft carrier or destroyer). That initial hull concept decision then influenced a lot of the other design trades for the ship systems.

Initially none of the shipyards had complete early stage design capability or naval architecture talent available. Each Team engaged a naval architecture firm as part of their effort.

All of the designs were heavily driven by the magazine protection systems. The one week Survivability Course provided by the Government at the beginning of Phase II marked the start of this effort. In addition, the Teams brought the NSWC Vulnerability Group onboard, some to a greater extent than others. The trades driven by the physics of the problem were very clear and each Team chose a different approach consistent with their hull design concept.

All of the Teams integrated their production engineering and planning early in the process and used design innovations to try to improve the production process. This was motivated by the requirement to provide an irrevocable offer as part of the Phase III proposal. This effort included developing a build strategy, module break concept and process layout in some detail.

All of the Teams focused on using some form of commercial specifications and materials. All used commercial grade with no HY-series steel.

The mission profile of both a high speed transit and a 90 day loiter speed on station suggested some form of electrical propulsion or auxiliary propulsion system.

All of the Teams used commercial specifications for most of the equipment and relied on some form of rafting or isolation to protect the equipment from shock or environmental effects.

3.4.2 Process and Production Lessons Learned

3.4.2.1 For industry to significantly alter the way they do business (as was done for the Arsenal Ship Program), they must create project teams largely separate from the parent organization and its associated culture and bureaucracy. Further, these project teams must be empowered to implement change. Large corporations have a deeply ingrained culture

in which it is difficult to deviate from the norm. It is simply not possible for an entire company to change on short notice for a single project. All of the Arsenal Ship Industry Teams enjoyed considerable autonomy and respite from much of the bureaucracy of the parent companies. The Teams must have full ownership and responsibility for design, fabrication, assembly and test.

3.4.2.2 Repeatability and Commonality significantly enhance productivity. Navy-designed ships have relatively little "commonality" or inherent production repeatability. The Arsenal Ship Industry Teams made extensive use of repeat structural segments, mirroring of the ship (port and starboard sections identical), and common modules.

3.4.2.3 Significant industry cost and schedule savings can be realized through the integrated efforts of engineering, production, procurement, logistics and cost estimating personnel. Typical industry practice involves stove-piped efforts of engineering, production, procurement, logistics and cost estimating personnel. This practice provides for less than optimum products and processes resulting in increased costs and greater cycle times. Integrating the various groups can yield significant gains in cost and schedule. For example, as engineering conducts the design, drawings are produced that optimize production, equipment can be chosen to optimize procurement options, supportability can more readily be designed-in up front, and the impact of various design options on acquisition and life cycle costs are all available in real-time.

3.4.2.4 The use of Other Agreements Authority, Sec. 845, did allow savings especially in the area of material selection where the traditional process could be replaced with a commercial approach. . Relief from Competition in Contracting Act (CICA) was particularly valuable in that Teams could solicit for the best total vendor "package" of cost, technical support, training, upgrades and service life logistics rather than be forced to select the vendor with the lowest acquisition cost. Related benefits include: (1) allowing Industry to nurture long term relationships, (2) the numerous benefits, such as reduced non-recurring costs, associated with doing business with a company that is familiar (3) reduced cost and time associated with contracting, and (4) benefits associated with providing engineering with more design data at an earlier stage. It should also be noted, however, that to maintain a favorable negotiating position it may be necessary for industry to protect or conceal their early decision to go with a particular company

3.4.2.5 Commercial building practices may be readily applied to naval ship combatant construction. Despite the shock, whipping, signature, weapons effects, and other military features built into Arsenal Ship, the Industry Teams demonstrated that it is entirely possible to take advantage of commercial practices, such as: (1) parallel structure and outfit construction processes, (2) reduced number of installation parts, (3) "building block" vice "stick built" products, and (4) repeatable products and processes. The approach that seems to maximize the commercial benefits is to start with a 100% commercial criteria and then add military criteria only when required.

3.4.3 Design Lessons Learned

3.4.3.1 Similar trade studies conducted by different Teams may lead to results not only quite different from each other, but inconsistent with current Navy thinking. Although the Industry Team solutions had many similarities, there were stark differences as well. These differences are a result of differing assumptions, company culture, goals and objectives. One example is the different types of propulsion system chosen by each of the three Teams. In one case, the type of propulsion system seemed inconsistent with that type of system deemed most advantageous based on recent Navy trade studies.

3.4.3.2 Industry should have maximum ability to establish those requirements that impact their production process and products. To minimize cost and schedule, Industry Teams must be able to optimize use of their unique facilities, personnel, processes and expertise. Freeing Industry affords them that opportunity. Examples include (1) choosing steel plate sizing that optimizes their production line, (2) allowing industry to establish construction breaks, block sizes, packaging of equipments, etc. to account for plant layout, lift capability, etc.

3.4.3.3 Skid mounting equipment, while affording production efficiencies, actually adds weight. Industry trade studies clearly determined that skid mounting equipment provided for significant cost and schedule advantages. It does, however, add weight. This added weight is an important consideration for weight sensitive designs.

3.4.3.4 Less dense ships increase design flexibility and lower cost. Allowed to generate their own requirements and designs to maximize performance under PAE, all three Teams developed designs more "spacious" than Navy standards. Beneficial results included: areas designated for distributive systems (service trunks), longer and straighter piping runs, simplified vent ducting requiring fewer parts, etc..

3.4.3.5 Raft mounting COTS equipment to provide for shock isolation, appears to be technically feasible and provides for significant savings in acquisition, production, and life cycle costs. While detailed analyses of the shock mitigating abilities of the rafts was not conducted, preliminary results indicated that it was indeed achievable. The majority of the cost savings are realized through the purchase of COTS equipment.

3.4.3.6 The right mix of fire fighting systems was difficult to determine and the subject of considerable design studies. Through the conduct of extensive trade studies, industry determined that water mist provided the most effective means of extinguishing fires (in conjunction with foam in machinery spaces), was cost effective, and that acceptable commercial systems were readily available. It is not clear why the Navy is pursuing their own water mist system given the fact that commercial systems are currently in use, especially in cruise ships.

3.4.3.7 Acceptable options are available to provide for a low signature, low manning, operationally effective and a safe aviation support facility. Through discussions with

NAVAIR, NAVSEA and NAWC Lakehurst, the Industry Teams determined that it was indeed possible to design a helicopter landing facility to meet established signature goals.

3.5 Missile Launchers

3.5.1 Background

3.5.1.1 Phase I - Concept Studies

The CONOPS/SCD specified the need for about 500 VLS cells. This was initially assumed (but not required) by ASJPO to mean MK41 cells, since the cost of a new launcher development was deemed well beyond the scope of the program. Since GFE was eliminated, the launcher was left unspecified primarily to keep in the spirit of free and open trade space given to the Teams. Therefore, at the outset of Phase I, ASJPO wanted to ensure equal access to design data and potential cost reduction modifications for the MK41 VLS Launcher, with Lockheed Martin Aero Naval Systems (LMANS), the sole source Industry Team to PMS-410. LMANS was requested to support all competing Teams which they ultimately did.

None of the Phase II competing Teams chose the current MK41 VLS system. There were at least four business factors that swayed the Teams away from MK41: (1) since approximately 1/3 of the total ship cost was in launchers, too much of their trade-space would have been locked out if forced to use the MK41 as a fixed cost element, (2) LMANS, and by inference the whole LM Team, would have too much insight into a competing Team's design, (3) even if LMANS had been more flexible on trades and pricing, the profit for 1/3 of the ship would go to a non-Team member, and (4) the potential for launcher profits on SC-21 was even a larger draw than Arsenal Ship for future launcher sales (effectively, Arsenal Ship would be helping support the winning Team develop a launcher to compete with MK41 on the SC-21 program).

As the competing Teams initiated the search for MK41 launcher alternatives, they found they had three options: (1) develop a new launcher from scratch, (2) partner with NSWC/Dahlgren on the CCL (Concentric Canister Launcher) program, or (3) work with UDLP (United Defense) who was a MK41 supplier when there were two manufacturers. All three approaches were taken by various Teams.

3.5.1.2 Phase II - Functional Design

Tests were needed to reduce development risk to an acceptable level by the end of Phase II and prior to downselect for detail design and construction in Phase III. This necessitated use of representative missile loads. The Government made available spare rocket motors, missile parts and standard VLS canisters at no cost to support the tests. Help from PMS-410 and PMS-422 was indispensable in obtaining these parts and to ensure safe tests.

The fact that launcher tests could be accomplished in the short time period of Phase II is an indication of the maturity of vertical launcher design. With performance essentially ensured, much more concentration could be devoted to the production and cost aspects of the design. All Teams did an in-depth, cost estimate that included materials, labor and process costs.

In parallel with Arsenal Ship Joint Program Office (ASJPO) reviews of the launcher designs, the Weapons Systems Explosive Safety Review Board (WSESRB) conducted a series of safety reviews for the weapon system and its associated systems including the launchers, the computers, software, fire fighting and damage control features affecting explosive safety. ASJPO insisted that all industry designs be driven through the WSESRB, so that the question of weapons firings in Phase IV of the program would not become a contentious issue. The Board advised all Teams (through the ASJPO) on concerns and issues and were very supportive. They were open-minded about the often novel way in which the Teams were developing their designs and focused instead on the desired performance of safety features rather than their specific implementation.

3.5.2 Process Lessons Learned

3.5.2.1 New launcher developments were a surprise to the program office. Launchers are a major cost item for the ship and were treated as a mandatory new development by each Industry Team to attain a competitive edge. This should be expected on any new competitive procurement where a major item is not specified as Government Furnished Equipment (GFE). It also occurred because the MK41 legacy system was owned by one of the competitors who then would have held too much influence over their cost structure and too much insight into their design.

3.5.2.2 Only industry can conduct meaningful cost analysis of such systems as launchers. Government does not have the expertise nor data to perform the detailed cost analysis necessary to estimate prices of major weapons systems such as launchers.

3.5.2.3 WSESRB is a vital part of the Governmentís explosive safety program. WSESRB's function is to review and comment, not approve or direct. It advises the program manager who is responsible for program safety. Industry Teams are not in a position to accept liability for use of explosive ordnance. Detailed design issues are not normally evaluated by the WSESRB - it looks at the processes in place and the results.

3.5.3 Launcher Technology Lessons Learned

3.5.3.1 VLS launchers have become a mature technology. The short development time and low investment cost involved for new launchers development point to a mature technology. Development time for Arsenal Ship launchers would have been about 1/2 that for MK41 with development costs perhaps 1/10.

3.5.3.2 Risk reduction on launcher systems requires some live testing. Modeling and simulation is not enough because aspects of launcher systems cannot be modeled properly, e.g., ablative erosion.

3.5.3. 3 There are numerous high quality launcher testing facilities available. Several private as well as Governmental launcher test facilities were utilized for the launchers. All had modern measurement equipment, test setups and qualified personnel.

3.5.3. 4 The Government still needs to invest in survivability features and tests. Survivability features of launchers and other systems are still unique needs of the services and are not supported by commercial suppliers. This means that the Antifragment and Explosive Load Reduction (ELR) systems development might have to be borne primarily by the Government, either through a separate effort that was made available to all Industry Teams, or through extra investment in the Arsenal Ship project, with funds going to the single Team entering Phase III. During Phase II, ASJPO invested some funding in testing ELR systems applicable to all Teamsí launchers.

3.5.3.5 Government often has free assets available for testing at no cost. Older rocket motors (MK104) near the end of their service life were made available for tests. A few R&D motors (MK72) were available because they were not production units. Canisters with defects were also available. They were given to the Teams as no-cost GFE. Significant help from PMS-410 and PMS-422 made this possible.

3.6 Operations & Support

3.6.1 Background

The subject of Operations and Support encompassed manning, maintenance & repair, operating cycles, forward operating bases, and central operating bases. Issues such as Personnel Tempo of Operations (PERSTEMPO) and dry docking cycles were addressed. All the Teams considered the Blue and Gold crewing concept and the use of civilians for ship operation. The use of military and civilian personnel, both civil service and private industry, was considered to perform maintenance. Phase VI of the program optionally allowed the Teams to propose providing the life cycle maintenance for the Arsenal Ships. All indicated they would propose providing life cycle maintenance.

3.6.2 Lessons Learned

3.6.2.1 The right approach to designing for very low manning is to start with zero manning and justify each billet. A zero-based approach that looks at whether the function is necessary at all or whether it can be eliminated by more extensive use of technology (e.g., long life hull coatings) and/or automation works! While all of the Teams achieved a very low manning number it was not fully determined whether the required maintenance underway could be achieved, with the issue of corrective maintenance being the most elusive. It was also not clear if housekeeping and food service were adequately addressed.

3.6.2.2 Manning reductions should be evaluated from a total ownership cost viewpoint. The military and civilian manning to operate the entire system, from administration, technical support, maintenance support, ship operation and possibly with multiple crews, must be considered. A very small afloat crew with an extensive shore support staff for maintenance is not necessarily less expensive than a larger afloat crew that performs some of its own maintenance. Manpower reductions must reflect the elimination of work rather than the transfer of work to a different venue (although transfer of work ashore may permit it being done at less cost than afloat).

3.6.2.3 It is important to constantly stress the balancing of operations & support costs and acquisition costs. There is now little doubt that major crew size reductions are possible. The question is whether the non-recurring engineering (NRE) effort, including software development and modeling & simulation, will be sufficient to allow a few people to operate the ship. Additionally, appropriately reliable equipment and systems must be selected to reduce maintenance workload. The in-service maintenance concept must be worked out in sufficient detail to ensure realistic maintenance cost estimates.

3.6.2.4 To achieve proposed manpower reductions, selection of appropriate equipment and systems must be matched to reliability, repair, and maintenance criteria. During the early stages of design (e.g., Phases I and II) most equipment have not been selected, yet manning

reductions are postulated. The criteria for making future procurement decisions for individual systems or equipment must ensure that the proposed ship availability and crew maintenance workload are not compromised.

4.0 SHIP COSTS

4.1 Background

4.1.1 Philosophy: PAE

From its initial conception, the Arsenal Ship Program has steadfastly applied Price As Established (PAE) as a major component of its acquisition strategy. Price here means industry cost to manufacture and a reasonable profit (or return of investment to the company). A price goal was established early in the program. All designs were monitored by the contractor teams to ensure an affordable item at a price including all non-recurring and recurring costs to manufacture and a reasonable return on corporate investments or in other words, profit. All other aspects of the government desired capabilities were tradable against the price goal. This is different from Cost as an Independent Variable (CAIV). Cost as independent variable (CAIV) assumes two things; first, the government is monitoring and controlling the trade decisions to ensure affordability, and second, cost is only one of several factors to be traded. Requirements creep is most certain. CAIV in present government literature means a government program manager yardstick to consider trades against requirements.

After several months, all competitive teams were to fix their own price against their design or PAE. During later phases more trades could result. The contractor team should have responsibility for all trade decisions and be encouraged to use the trade space within the government's desired capabilities to ensure an acceptable and capable product that meets PAE. PAE focused the design trades on mission essential performance, without requiring the use of legacy systems as GFE (Government Furnished Equipment). This resulted in designs that were engineered at a total system level, highly integrated, commercially-based, and low cost, while at the same time introducing new systems with some attendant risk. Industry Teams were prepared to meet the goal of $450M for the average production ship cost, about 1/3 less than early Navy estimates for the production ship. Risk reduction programs were key to achieving the PAE goals and worked effectively. Under the Arsenal Ship acquisition strategy, substantial elements of the risk were transferred from Government responsibility to Industry. In short, competing teams concluded “zero risk is unaffordable.”

PAE has been applied across all phases of the life cycle. The Phase V Unit Sailaway Price (USP) goal of $450M and the Phase III budget of $389M were established before the start of Phase I. Goals for annual operating and support cost ($13.7M per ship) and total program life cycle cost ($5.7B) were established early in Phase II. The competing Industry Teams were given full flexibility in designing the ships, in controlling the business environment and production process, and specifying the operating and support concept within the Concept of Operations (CONOPS) and Ships Capabilities Document (SCD).

4.1.2 Government Cost Team Tasks

The ASJPO cost team openly interacted with the three competing Industry Teams, providing feedback and encouragement, during Phase II. Government tasks included:

- Establish an "aggressive but realistic" goal for the O&S Phase; integrate goals for all program phases into an overall life cycle goal. The cost goal for the development phase (Phase III) and the USP goal for Phase V were established at program initiation.
- Analyze deliverable products and Phase II cost proposals and provide evaluation and recommendations to the Source Selection Evaluation Board (SSEB).
- Develop a consistent but flexible structure for collecting, assessing, and comparing Industry Team cost proposals.
- Provide forthright, but non-directive, feedback to the Industry Teams regarding their cost estimating assumptions, cost modeling approaches, and supporting rationale.
- Through close interaction with industry, develop an understanding of the impact of commercial practices, manufacturing and design process improvement, simplified acquisition practices, and alternative approaches to life cycle support on all aspects of life cycle cost.
- Assess the realism of the Teams' cost proposals in view of the following factors:
  - — Experience with performance on current and past programs
  - — Commercial practices to the extent incorporated in the Teams' designs
  - — Acquisition Process streamlining (Sec. 845, etc.)
  - — Application of state of the art systems and technology
  - — Improved manufacturing and management practices where credibly supported
  - — Relevant attributes of the ship concepts

4.1.3 Industry Cost Teams

The three Industry cost teams played a major role in the implementation of PAE in their design processes. Each of the three teams had its own individual organization and approach. A number of common characteristics became evident over the course of Phase II. A representative generic process, followed to some degree by all of the teams, included the following tasks:

- Implement PAE as part of the team's system engineering process.
  - — Flow down top-level PAE goals to subsystem IPT's.
  - — Actively participate in subsystem IPT's to provide real-time cost sensitivity.
  - — Define and perform cost trade studies in support of system configuration decisions.
  - — Act as the "cost police" to ensure continuous emphasis on cost in the design process.
  - — Flow up and integrate subsystem cost estimates into overall program cost.
- Ensure life cycle considerations were prominently addressed in the system design.
  - — Participate in the development of life cycle system support concepts.
  - — Perform RMA and maintenance cost assessments. Motivate designers to address maintainability in the design process.
  - — Perform manning and training assessments to ensure the consistency and feasibility of the manning and support concepts.
- Improve corporate methods and tools for collecting, managing, and promulgating cost information across the program team.
- Provide realistic assessments of program cost and feasibility to corporate management.

- Interact with unprecedented openness with program office representatives, including cost engineers, during the development of a major acquisition proposal.
  - — Understand customer concerns re cost visibility and realism.
  - — Provide necessary backup information and data to make the case for credibility of cost estimates based on commercial practices, new processes, and non-traditional business arrangements.

In summary, the program's approach to PAE and ship cost required an unprecedented degree of cooperation between a Government program office and each of three Industry Teams in a competitive situation. Good will, highly professional attitudes and behavior, and commitment to this new way of doing business by everyone involved were required to make it work

4.2 Lessons Learned

4.2.1 PAE Works. In a competitive environment, industry will strive to meet aggressive PAE goals.

4.2.2 Non-traditional acquisition processes offer opportunities for substantial savings. Expectation of 30-50% (or more) savings vs. traditional process can be supported if industry is given freedom from standard acquisition constraints. Competition is a very powerful motivator and can be used to ensure industry uses this freedom.

4.2.3 Close interaction between Government and Industry Cost Teams is beneficial to both sides. Government representatives must be very careful to protect proprietary information of each competitor. Industry personnel must learn to "let down their guard" and be reasonably trusting and open. Government gets unprecedented understanding of Industry's proposal and process and Industry better understands the customer's needs and produces better proposals

4.2.4 Early emphasis on reducing total ownership cost (TOC) is required to produce meaningful results. Early design choices and equipment selection have a significant effect on procurement and maintenance costs. Making O&S costs an issue encourages the Industry Teams to trade-off for more reliable equipment and to design out some traditional maintenance. Significant maintenance reductions were predicted from re-engineering legacy equipment and performing manufacturer recommended maintenance.

4.2.5 The integrated product team (IPT) concept, that combined cost and production engineers with designers in the early stages of the program, led to predicted ownership costs considerably below historical levels. Significant process changes in both management and production were required to justify the use of non-traditional cost estimating relationship's (CER's) but when validated, predicted significant savings. Industry cost engineers were the crucial players ensuring that IPT's focused on cost from beginning to end of the process. Production engineers' early involvement was key in the evolution of designs for which a supportable case for lower than historical production costs could be made.

4.2.6 Use of cost models based on conventional weight-based methods for unconventional designs can lead to erroneous results. In several instances Industry Teams utilized weight-based cost estimating to estimate such areas as labor hours, paint, lagging, etc. A closer look revealed that weight-based cost estimating gave answers that were not accurate, and over inflated.

4.2.7 Product design details can be adjusted to improve producibility and substantially reduce cost. Designs evolved to utilize repeatable modules, to increase plate thickness and reduce numbers of parts, to employ COTS components where possible, and to tradeoff machinery configurations in an effort to minimize cost. Historically- based CER's can

not easily capture these cost impacts; a more detailed and process sensitive methodology is required.

4.2.8 Industry offered credible life cycle support under a Full Service Contractor (FSC) approach. The FSC approach promises significant cost savings over traditional Navy life cycle support.

4.2.9 The key to PAE is to treat cost as another design requirement for the engineer and provide a detail budget breakdown at the outset. Although all of the Teams practiced some form of PAE, in the end those that had an early budget in Phase I had a better handle on costs and had more time for total ship trade studies..

4.2.10 There is a distinct advantage to use design tools that include real-time cost estimating. Industry Teams found it important that cost estimates associated with system design be available in real-time to accommodate faster design cycle times. Use of design tools that did not provide real-time cost estimates necessitated a separate effort to determine cost impacts.

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Glossary

ACAT	Acquisition Category
AFATDS	Advanced Field Artillery Tactical Data System
AFS/ELR	Anti-Fratricide System/Explosive Load Reduction
AOA	Assessment of Alternatives
ASJPO	Arsenal Ship Joint Program Office
ASN	Assistant Secretary of the Navy
ASOS	Arsenal Ship Off-board Systems
ATWCS	Advanced Tomahawk Weapon Control System
CAD	Computer Aided Design
CAIV	Cost As an Independent Variable
CCAT	Combat System C4I Assessment Team
CCL	Concentric Canister Launcher
CD	Carderock Division
CEC	Cooperative Engagement Capability
CER	Cost Estimating Relationship
COEA	Cost and Operational Effectiveness Analysis
COMM	Communications
CONOPS	Concept of Operations
COTS	Commercial Off the Shelf
C4I	Command, Control, Communication, Computers and Intelligence
CS	Combat System
CSS	Coastal Systems Station
DARPA	Defense Advanced Projects Agency
DBOF	Defense Based Operating Fund
DD	Dahlgren Division
EHF	Extra High Frequency
FFRDC	Federally Funded Research and Development Center
FOUO	For Official Use Only
FSC	Full Service Contractor
GFE	Government Furnished Equipment
GFI	Government Furnished Information
GOTS	Government Off-the-Shelf
GSE	Government Specified Equipment
HM&E	Hull, Mechanical & Electrical
HY Series	High strength milspec steels
IMPS	Integrated Magazine Protection System
INFOSEC	Information Security
INSURV	Inspection and Survey
IPDE	Integrated Product Development Environment
IPT	Integrated Product Team
IRAD	Independent Research & Development
JHU/APL	Johns Hopkins University/Applied Physics Lab

JROC	Joint Requirements Oversigh Council
JSTARS	Joint Surveillance, Target Attack Radar System
JTIDS	Joint Tactical Information Data System
LAWS	Land Attack Weapons System
MFS	Maritme Fire Support
MNS	Mission Needs Statement
NAVAIR	Naval Air Systems Command
NAVSEA	Naval Sea Systems Command
NAWC	Naval Air Weapons Center
NRL	Naval Research Laboratory
NSWC	Naval Surface Warfare Center
NSWC/PHD/ECO	Naval Surface Warfare Center/Port Division/East Coast Operations
OPTEVFOR	Operational Test and Evaluation Forces
O&S	Operating and Support
OSD	Office of the Secretary of Defense
PAE	Price As Established
PARM	PARticipating Manager
PEO	Program Executive Office
PERSTEMP O	Personnel Tempo of Operations
PGM	Precision Guided Munitions
POM	Program Objectives and Milestones
RD&A	Research Development and Acquisition
RMA	Revolution in Military Affairs
SBD	Simulation Based Design
SCD	Ships Capabilities Document
SEI	Software Engineering Institute
SETA	Scientific and Engineering Technical Assistance
SPAWAR	Space and Naval Warfare Systems Command
SPO	Special Projects Office
SSA	Source Selection Authority
SSEB	Source Selection Evaluation Board
SSAC	Source Selection Advisory Council
SWBS	Ship Work Breakdown Structure
TAD/SD	PEO TAD program office for Ship Self Defense
TADIL	Tactical Digital Information Link
TCP/IP	Transport Control Protocol/Internet Protocol
T&E	Test and Evaluation
TOA	Total Obligational Authority (in the budget)
TOC	Total Ownership Cost
TTO	Tractical Technology Office
UARC	University Affiliated Research Center
USA	United States Army
USD (A&T)	Under Secretary of Defense (Acquisition and Technology)
USMC	United States Marine Corps

USP	Unit Sailaway Price
VGAS	Vertical Gun Advanced Ships
VLS	Vertical Launch System
WD	Weapons Division
WSESRB	Weapon Systems Explosive Safety Review Board

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JOINT MEMORANDUM

MEMORANDUM FOR COMMANDER, NAVAL SEA SYSTEMS COMMAND
CHIEF OF NAVAL RESEARCH

Subj: ARSENAL SHIP PROGRAM

This joint memorandum establishes the Arsenal Ship Program and provides the Director, Defense Advanced Research Project Agency (DARPA), Commander, Naval Sea Systems Command (NAVSEA) and Chief of Naval Research (CNR) with precepts regarding the basic requirements, goals, and acquisition strategy for the program.

The basic requirement for the Arsenal Ship is to satisfy joint naval expeditionary force warfighting requirements in regional conflicts by providing the theater commander with massive firepower, lone range strike; and flexible targeting and possible theater defense through the availability of hundreds of VLS cells. To meet this warfare requirement affordably, the Arsenal Ship concept and design must be straightforward and simple. Detailed requirements and concept of operations are defined in separate documentation, however, key elements for the Arsenal Ship include-

- Provide approximately 500 VLS calls, with the capability to launch Navy and joint weapons to support the land campaign;

- Integrate the combat system with Cooperative Engagement Capability (CEC) links to serve in, or as, the off-board control;

- Appropriate ship design features for survivability and ship self defense which could be incorporated at a later date if needed;

- Low ownership Costs through the use of innovative maintenance and operational methods, procedures, and technologies;

- Crew size will not exceed 50 personnel. The design objective will be to minimize crew size to the maximum extent below 50 which is technically feasible.

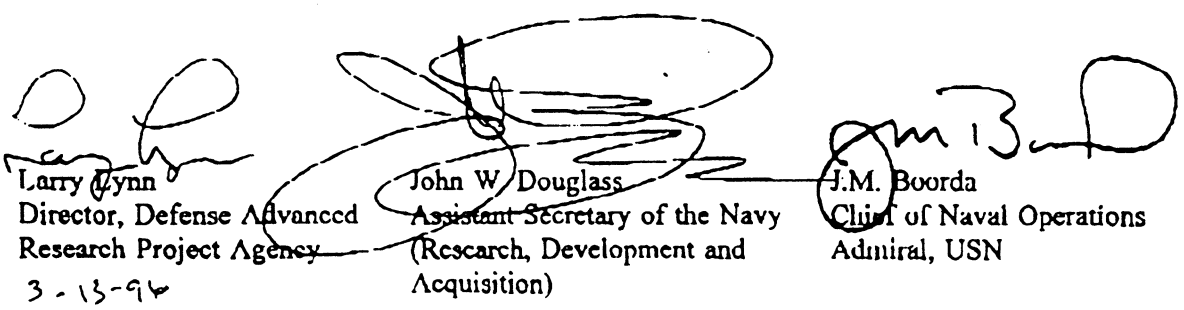
In the face of limited budget levels, the use of acquisition reform initiatives and streamlined contracting methods are paramount to meet the basic requirements of the Arsenal Ship in an affordable manner. To accomplish this, a non-acquisition category demonstrator ship shall be developed that will be convertible to a fleet asset at a future date.

In addition, cost must be viewed as an independent variable, and early industry involvement with the development of a cooperative industry-government team are viewed as key to achieve our goals. To minimize cost, the off-the-shelf systems will be used exclusively. Any development of new systems will require the approval of ASN (RD&A). The cost of acquiring the first ship will not exceed $520 million including the cost of concept development and competition. These funds will be provided jointly by the Navy and DARPA with contributions of $350 million and $170 million respectively. For FY 96, funds will be provided by reprogramming. For FY 97, funds will be requested as part of the budget request. The Program Objectives Memorandum process will be used to provide the funding.

The Director, DARPA; Commander, NAVSEA; and CNR are tasked to establish a plan for a joint Arsenal Ship Advanced Technology Demonstrator Program Office and identify to the ASN (RD&A) a candidate full-time program manager. The program manager will work closely with OPNAV staffs to ensure that requirements are understood and fully met, and with industry in a team approach to ship development and construction. The Arsenal Ship Program Office (ASPO) should operate as a "skunk works" organization, eliminating, or streamlining acquisition procedures, processes, and paperwork. The ASPO shall be comprised of representatives from DARPA, NAVSEA and CNR with a total maximum number of 9 personnel. DARPA will initially have program lead with transition to NAVSEA at an appropriate time during ship production. This program represents a good opportunity to take advantage of DARPA's culture and experience in prototyping to transition alternative business practices into how the Navy buys ships. The ASPO shall be initially located in the National Capitol Region and later co-located at the shipyard chosen to construct the first ship.

DARPA, NAVSEA, and CNR are directed to develop a detailed plan of action, milestones, technology initiatives, acquisition strategy, and budget necessary to execute the Arsenal Ship Program, with the goal to have a demonstrator Arsenal Ship at sea by the year 2000. Specific recommendations and actions necessary to accelerate ship development should be the focus of the plan, eliminating all procedures that are not specifically required by law. The plan should also provide systems integration approach and affordability initiatives to reduce acquisition and ownership costs.

The Arsenal Ship Program is among the highest priority programs within the Navy. All organizations and contractors participating in and supporting the Arsenal Ship Program should view it with priority, and proceed with a sense of urgency to achieve the goal of beginning demonstrator ship at-sea testing of the Navy's first Arsenal Ship in the year 2000.



Larry Lynn
Director, Defense Advanced
Research Project Agency
3-13-96

John W. Douglass
Assistant Secretary of the Navy
(Research, Development and
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MEMORANDUM OF AGREEMENT (MOA)
JOINT NAVY/DARPA ARSENAL SHIP
DEMONSTRATION PROGRAM

Purpose:

The purpose of this document is to establish a joint Navy/DARPA agreement as to the objectives, roles and responsibilities, schedule, and funding for the Arsenal Ship demonstration program.

Background:

Arsenal Ship is a high priority program for the Navy to acquire a new capability for delivery of large quantities of ordnance in support of land and littoral engagements. Key to both Arsenal Ship's affordability and operational flexibility is off-board integration of all but the most rudimentary C4I. The ships are conceived to be theater assets that will operate under the authority of the joint Commanders-In-Chief (CINCs) and will receive their targeting along with command and decision information from other assets. Early in Arsenal Ship's life this control will be exercised through an Aegis platform, though as other assets mature, control will transition to aircraft such as AWACS or an E-2 with CEC-like capability and eventually to the Marine or Army shooter on the ground. Thus, the Arsenal Ship will not be fitted with long range surveillance or fire control sensors, but will be remotely controlled via robust data links. The data links will be secure, redundant and anti-jam in order to provide high reliability in the connectivity of the Arsenal Ships in high jamming operational scenarios. The program overall is an attempt to leverage the significant current joint investment in Link 16 and CEC. The Arsenal Ship's survivability will be primarily achieved through passive design techniques. While active systems are not ruled out, they must be consistent with overall cost and manning goals. These design goals will allow the Arsenal Ship to have a very small crew (potentially, none at all) which will be a key ingredient in minimizing its life cycle costs. It is expected that the Arsenal Ship will transit and operate independently but when in a hostile environment, its defense will be enhanced by working cooperatively with other elements of the force. It is envisioned that the Arsenal Ship will be a large hull designed so that the weapons carried onboard are protected from damage and the ship is "virtually unsinkable" if hit by missiles, torpedoes, or mines.

This demonstration program is a non-ACAT program that has been created to evaluate this new capability while minimizing the risks in acquisition of approximately six ships. To ensure that the program remains affordable, a firm cost threshold for the production ships has been established. This program will be conducted using DARPA's Section 845 Agreements Authority so as to allow industry wide latitude in satisfying the Navy's requirements within this threshold. Agreements will be structured to allow tradeoffs between cost and performance. Program success will be judged by the extent to which the Arsenal Ship meets operational requirements.

A second purpose for this demonstration program is to accelerate the Navy's ongoing acquisition reform activities focused on buying improved ships at a lower cost. To this end, the joint program will focus on exploiting DARPA's culture and experience in prototyping system

programs. We anticipate the production Arsenal Ship contracts will serve as a model for future streamlining.

Technical Objectives:

The Arsenal Ship is intended to provide a large quantity of (approximately 500) vertical launch systems (VLS) with the capability to launch a variety of weapons for strike, fire support, and area air defense. The exact number of VLS missiles will be determined during the program by optimizing the survivability, performance, sustainablity and costs. The demonstration program will highlight Arsenal Ship's capability as a force multiplier to the Marine Corps, Army, and full array of joint forces. In that regard, it is recognized that certain weapons do not yet exist in the inventory that would allow the full capability to be demonstrated for all missions. No new weapons developments or significant enhancements to weapons are to be pursued as part of this program. Instead, demonstrations should be planned and structured such that significant communications, architecture, and data link functions are evaluated. The goal of the program will be to achieve a balanced design that satisfies the thresholds consistent with the ship's concept of operations (CONOPS).

The demonstration program must show that the production Arsenal Ships are suitable for performing their mission within prescribed cost constraints. To this end, its objectives are to demonstrate:

1. The performance of the mission for 90 days.
2. The architecture, communications, and data link functions to satisfy the Arsenal Ship CONOPS.
3. The capability for remote launch of strike, area air warfare and fire support weapons. It is envisioned that the test program will include:
    a) Salvo launch of up to 3 Tomahawk missiles in 3 minutes
    b) Single SM2 launch using the arsenal ship as a remote magazine for a Cooperative Engagement Capability (CEC) ship
    c) Single Tomahawk launch using the arsenal ship as a remote magazine for air directed and shore based targeting
    d) Single ATACMS launch from a VLS cell in support of a naval surface fire control mission digital call for fire
4. That the proper balance between passive survivability and active self defense will be sufficient for the expected operating scenarios.

Cost Threshold: $550 M

The acquisition cost threshold is based on the average Navy SCN end costs for the five follow ships acquired after this demonstration program, expressed in FY98 dollars. The costs of the weapons are not included.

Life Cycle Costs:

Industry will be tasked to perform the life cycle cost analyses to demonstrate the operating and support costs for their Arsenal Ship design over a 20 year life. This will ensure that the tenets of the program including reduced manning and innovative operating concepts remain focused on minimizing life cycle costs.

Schedule:

The goal of the demonstration program is to have the ship in the water and ready to start meaningful testing in the year 2000. The program manager will maintain a detailed schedule toward this end and present the plan for approval by the Steering Committee. The basic acquisition strategy for this program is to maximize industry involvement through a competitive multi-phase approach to encourage the maximum innovation within the limits of the cost thresholds. The Government, through the program office, will coordinate with industry to ensure the availability of information that the industry teams need to make informed trades.

Funding:

The cost of the R&D program for this demonstration Arsenal Ship will not exceed $520 million including the cost of concept development and competition. These funds will be provided jointly by the Navy and DARPA as follows:

(DOLLARS IN MILLIONS)

	FY96	FY97	FY98	FY99	FY00	FY01	TOTAL
Navy	$3.0	$25.0	$141.0	$90.0	$80.0	$11.0	$350.0
DARPA	-	$15.0	$47.0	$50.0	$36.0	$22.0	$170.0

The Navy will provide its share of the funds to DARPA at the beginning of each fiscal year.

Roles and Responsibilities:

This joint Navy/DARPA demonstration program will be conducted under the auspices of DARPA's Section 845 Agreements Authority. DARPA will lead the demonstration program and will transition the leadership to the Navy in the later stages of the program, upon mutual agreement of the parties.

The program will be managed by a joint Navy/DARPA program office with the Program Manager reporting to DARPA. A small program office is envisioned. DARPA, Naval Sea Systems Command (NAVSEA), and the Office of Naval Research (ONR) will initially each provide two billets. It is expected that the program office will grow to a maximum of three billets each as the program grows to maturity. Additionally, Director, Surface Warfare (N86) and Marine Corps will designate program office representatives as CONOPS, Requirements, and Fleet Introduction Officer and Naval Surface Fire Testing and Evaluation Engineer, respectively.

The Navy shall develop a concept of operations (CONOPS) for the program that will be reviewed and considered for update as the program develops. The program office will use the CONOPS to guide the trade studies to be conducted by industry.

The Program Manager will develop a program plan including major decision milestones, and the development of a program transition plan. The Steering Committee will approve the initial program plan and thereafter will conduct quarterly reviews to assess progress and provide guidance to the Program Manager.

The Steering Committee will be as follows:

Director, TTO - DARPA Chairman
Deputy Assistant Secretary of the Navy (DASN, Ships)
Assistant Director, TTO for Maritime Programs - DARPA
Director of Surface Warfare - OPNAV (N86)
Director for Expeditionary Warfare - OPNAV (N85)
PEO for Surface Combatants
Office of Naval Research (ONR33)

An Executive Committee consisting of:

Assistant Secretary of the Navy (RD&A)
Deputy CNO for Resources (N8)
Director, DARPA
Commander, NAVSEA
Chief of Naval Research

will review the program at major decision milestones to evaluate the validity of program cost thresholds and provide re-direction as necessary.

Term of Agreement:

It is expected that this MOA shall remain in effect for the duration of the demonstration program. Early termination of the program due to funding unavailability, lack of legal authority or other reason beyond the control of the parties shall be a basis for termination of this MOA. Any termination shall be preceded by consultation among the parties.

APPROVED

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24 MAY 1996

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28 MAY 1996

ARSENAL SHIP
CONCEPT OF OPERATIONS

The arsenal ship concept is a direct outgrowth of the Navyís shift in focus from the open ocean to the littoral. It is fully consistent with ìForward...from the Seaî, and “Operational Manuever from the Sea”, and addresses current as well as anticipated future requirements for more decisive, responsive and varied naval support to the land battle. Through concentration of massive firepower, continuous availability and application of netted targeting and weapons assignment, the arsenal ship will increase dramatically the scope and relevance of surface strike and fire support. Tailored specifically to meet the heavy support challenge in the opening days of conflict, arsenal ship will bring firepower to bear in support of Unified CinC’s and ground commander plans and schemes of manuever as well as provide significant leverage during the early phases of crises response and control.

OVERVIEW

As the foremost world power, the United States will continue to maintain global interests, and therefore must be able to influence and respond to events with credible military presence and power projection capabilities. In the face of steadily decreasing overseas basing and a shrinking military budget, the United States must maintain the ability, in concert with allies, to execute timely combat operations across the spectrum of conflict. Naval forces, sustaining forward presence, will be key to successful introduction as well as early employment of ground forces.

Arsenal ship represents an affordable and much needed enhancement to our existing force of carriers and land attack capable combatants and submarines. It is not a replacement for these or for land-base air. Instead, it is part of the whole-just as the Battleship was a part of the whole for nearly a century. Operating under the control and umbrella of regularly deployed Aegis combatants, arsenal ship will supply substantial firepower, early: giving unified Commanders-in-Chief (CinCs) the capability to halt or deter invasion and, if necessary, enable the build-up of coalition land-based air and ground forces to achieve favorable conflict resolution. With a force totaling about six, arsenal ships will be stationed continuously forward, always available for rapid movement upon receipt of even ambiguous or limited strategic warning. Much like our maritime pre-positioning force, they will remain on station in support of a Unified CinC for indefinite periods without dependence on host nation support or permission.

OPERATIONAL CONCEPT

With about 500 missiles and space for future extended range gun systems, arsenal ships will be capable of launching many current and planned Department of Defense weapons across the warfare spectrum. Arsenal ship can be positioned to destroy the enemy’s critical infrastructure at or near the inception of hostilities. Using precision guided missiles equipped with advanced penetrating warheads and sub munitions, this ship will

serve as an additional maneuver element in the landing force or ground force commander's plan by isolating, immobilizing, or destroying enemy forces, including enemy armored fighting vehicles, as well as providing fires in direct tactical support of ground forces.

Employing the Cooperative Engagement Capability (CEC) "remote magazine" launch concept, the Arsenal Ship will provide additional magazine capacity for Theater Ballistic Missile Defense (TBMD) and Air Supremacy missiles. This concept allows for remote missile selection, on-board missile initialization and remote launch orders, and provides remote "missile away" messages to the control platform.

To meet mission goals at affordable cost, ship design will be based on commercial practices and rely extensively on automation in engineering, damage, ship and weapon control systems to achieve a crew size of no more than 50. Berthing spaces for special evolution detachments will enhance operational flexibility.

Arsenal ship and associated weapon control systems will have the flexibility to be responsive to multiple commanders and to conduct simultaneous Long Range Strike, Naval Surface Fire Support, and Theater Air Defense missions. Tables 1 and 2 are representative of the type of capabilities desired.

	Halt Invasion	**Long Range Strike**	**Battlespace Dominance**	**Surface Fire Support**
Complex Adaptive Armed Forces	Air Land Maneuver Battle Groups (e.g., OMGs)	National / Regional C4I Space Control	Manned A/C TBMs, UAVs Cruise Missiles. SAM/AAA	Long-Range Artillery TBMs Logistics Assets
Armored Mech Armed Forces	Armor-Heavy Comb. Arms Formations Divisions/BDEs	National and Regional C4I	Manned A/C TBMs SAM/AAA	Long-Range Artillery
Infantry Based Armed Forces	Armor/Mech "Pure" units (BDEs/BNs)	Military Region District C4I	Manned A/C SAM/AAA	Medium-Range Artillery Logistics Assets
Internal Security Light Force	Transportation Railroads Trucking, Light Vehicles	National CMD Authority Military Concentrations	OP Bases Light A/C Coastal Patrol Craft	Logistics Assets Economic Asset Local Forces

Table 1. Target Sets to be Countered by Arsenal Ship

	Halt Invasion	Long Range Strike	Battlespace Dominance	Surface Fire Support
Complex Adaptive Armed Forces	SM-2/ATACMS-BAT SLAM TLAM-BAT TLAM-C	TLAM	ATACMS TLAM-C/D SM-2 Blk III A/B and Blk IVA SM-2 LEAP	ATACMS, SLAM, STRIKE-SM TLAM-C/D NAVAL GUNFIRE (VGAS/SCRAM)
Armored Mechanized Armed Forces	SM-2/ATACMS-BAT TLAM-BAT SLAM STRIKE-SM	SM2/ATACMS-BAT TLAM-BAT SLAM STRIKE-SM	ATACMS TLAM-C/D SM-2 Blk III A/B and Blk IVA	ATACMS, SLAM, STRIKE-SM TLAM-C/D NAVAL GUNFIRE (VGAS/SCRAM)
Infantry Based Armed Forces	ATACMS SLAM STRIKE-SM	TLAM-D ATACMS-ER	ATACMS	ATACMS, SLAM STRIKE-SM TLAM-C/D NAVAL GUNFIRE (VGAS/SCRAM)
Internal Security Light Force	NAVAL GUNFIRE (VGAS/SCRAM)	TLAM-C	ATACMS NAVAL GUNFIRE (VGAS/SCRAM)	ATACMS NAVAL GUNFIRE (VGAS/SCRAM)

Table 2. Weapons to Counter Target Sets

OPERATING ASSUMPTIONS

Arsenal Ship is a firepower multiplier that, in conjunction with other naval forces, increases decisively the options available to the theater CinC. The operational concept for Arsenal Ships is based on the following assumptions.

CinC Requirements. Arsenal Ships will be assigned to theater CinC to provide:

- Conventional Deterrence against regional aggression inimical to U.S. interests,
- Flexible response for demonstration of power independent of diplomatic limitations,
- Credible forward firepower support to joint and coalition land forces early in a regional contingency if deterrence fails. The forward theater arsenal ship weapon loadout will be robust, flexible and tailorable to CinC requirements in order to expand CinC options for use of assigned joint forces.

Joint Warfighting. Arsenal ships will be fully integrated into the joint warfighting force structure. The ships will be capable of firing a variety of weapons in support of a land campaign, including Long Range Strike, Invasion Stopping, Fire Support to Joint Ground Forces, Tactical Ballistic Missile Defense and Air Superiority.

Forward Operations. Arsenal Ships will be stationed, operated and supported in forward theaters for conventional deterrence and to provide immediate responsiveness upon onset of hostilities. The three forward theaters currently envisioned for arsenal ships are:

- Central Command (Southwest Asia / Persian Gulf),
- Pacific Command (Western Pacific)
- European Command (Mediterranean).

COMMAND AND CONTROL

Arsenal ships will operate in both peace and war as integral fleet units within the chain of command under Joint Combatant Command (COCOM). Peacetime Operational Control (OPCON) will normally be exercised by numbered fleet commanders. Within a Joint Task Force structure, OPCON will normally be exercised by the Joint Force Maritime Commander. Tactical Command (TACON) will normally be assigned to a naval commander.

JOINT CONNECTIVITY MISSION PLANNING AND TARGETING

Key to both arsenal shipís affordability and operational flexibility is off-board integration of all but the most rudimentary C4I. Joint connectivity, including targeting, mission planning, and weapons control will be provided to arsenal ship through the existing fleet of Aegis cruisers and destroyers. Employing an advanced, CEC-like weapons link, the wide array of joint connectivity needed for netted operations will be hosted through an assigned control ship. The role of target and user integration will similarly be performed off-ship, thereby significantly reducing arsenal ship manning, cost and developmental risk; while leveraging the extensive joint C4I investment (Link 16, CEC, etc.) already programmed for the majority of the Surface Navy. The complexity of varied tasking will be reduced to highly reliable, jam resistant targeting, weapons, and launch orders.

SURVIVABILITY

Though arsenal ship will operate in any threat environment under the protective umbrella of battle force combatants, it must be survivable against 21st century anti-ship missiles, torpedoes, and mines. Passive defense should capitalize on the benefits of mass (tonnage), innovative applications of multiple hull integrity, and signature reduction. Active self defense if required should be roughly equivalent to that of a combat logistics force ship.

MAINTENANCE

Arsenal ships are to be forward deployed for the large part of their operational lives. Low maintenance and high reliability must be engineered into ship design to assure high operational availability

ARSENAL SHIP CAPABILITIES DOCUMENT

This ship capabilities document (SCD) compliments the Arsenal Ship Concept of Operations (CONOPS) and provides definition of technical attributes that have evolved as part of ongoing study efforts. This SCD describes functions and capabilities for the Arsenal ships that should be treated as goals when conducting trade studies against the cost thresholds.

1.0 Design Philosophy

1.1 Arsenal Ship. The Arsenal ships are to be delivered fully equipped for fleet operations. They are to have maximized system performance consistent with the CONOPS and the SCD within the cost constraint. The Arsenal Ships should achieve commonality with current Navy systems whenever possible. Innovative approaches that leverage existing DoD investments are strongly encouraged.

1.2 Arsenal Ship Demonstrator. The Arsenal Ship Demonstrator may not initially have the full capability of the Arsenal Ships. The demonstration program must show that the Arsenal Ships are suitable for performing their mission within the price thresholds. To this end, its objectives are to demonstrate:

1. The performance of the mission for 90 days.
2. The required architecture, communications, and essential data link functions to support the Arsenal Ship CONOPS.
3. The capability for remote launch of strike, area Anti-Air Warfare (AAW) and fire support weapons. It is envisioned that the test program will include:
    a. Salvo launch of up to three Tomahawk missiles in three minutes
    b. Single SM2 launch using the Arsenal Ship as a remote magazine for a CEC (Cooperative Engagement Capability) ship
    c. Single Tomahawk launch using the Arsenal Ship as a remote magazine for air directed and shore based targeting
    d. Single weapon launch from a VLS Cell in support of a naval surface fire control mission digital call for fire.
4. That passive survivability will be sufficient for the expected operating scenarios.

The Arsenal Ship Demonstrator is to be capable of being converted to full mission ship capabilities and configuration and used as a fleet asset.

2.0 Warfighting Capabilities

2.1 General. The Arsenal Ship should be capable of firing a variety of weapons in support of a land campaign, including Long Range Strike, Invasion Stopping, Fire Support to Joint Ground Forces, Tactical Ballistic Missile Defense and Air Superiority.

2.2 Launching System. The ship should have about 500 VLS (vertical launch system) cells capable of launching current and planned vertical launch weapons. The actual number of VLS cells is to be recommended by optimizing the survivability, performance, sustainability and cost.

The ship is to have space, weight and support system capacity reservations for future installation of an extended range gun system.

2.3 Connectivity. Targeting, mission planning and command/decision functions will be offboard. The Arsenal Ship is to be connected to command platforms using the CEC "remote magazine" concept or an equivalent data link. An OTH satellite link capability is also to be provided. The ship is to be capable of full time communications with other ships, aircraft, satellites, and shore stations by means of responsive, reliable, clear and secure voice, tactical information distribution and recorded communications. Redundant links may be necessary to achieve robust interconnectivity. It is important that the Arsenal Ship be able to connect to existing joint force communications with minimum impact.

2.4 Survivability. The Arsenal Ship is required to be highly survivable in the entire littoral environment. Furthermore, consistent with the objectives for the Arsenal Ship to be an inexpensive platform with low life cycle costs, its' survivability should be achieved through passive means to the extent practicable. Passive techniques to be considered include the use of signature control and countermeasures to make it difficult to detect, target and hit the ship, design/systems that will protect the VLS from damage if the ship is hit, and considerations of ship designs such that the ship will be virtually "unsinkable".

It is expected that the offeror will perform analyses to consider a range of current and future threat systems in performing trade-off studies to develop appropriate levels of survivability that can be achieved within the USP. The threats should include sub-surface, surface and airborne systems. These analyses/trades shall lead to determinations if and where limited active self defense systems are needed to augment the passive design considerations, consistent with minimizing crew size and cost constraints.

The ship shall be able to operate in a chemical-biological-radiation (CBR) environment.

Ship features shall be provided to contribute to the ship's ability to stay afloat and resist further damage including: fire fighting systems, inherent ship stability in damaged conditions, redundant electrical and other support systems.

2.5 Mobility. The ship is to be capable of a sustained speed (80% of installed power) of at least 22 knots. The ship is to carry sufficient fuel to conduct a 90 day mission. The ship shall be capable of continuous, precise navigation under all conditions, day or night, independent of geographic location, weather and visibility.

2.6 Stowage Space. The ship shall be capable of storing of consumables and repair parts parts for a 90 day mission consistent with the maintenance concept.

3.0 Design Standards. The design life of the ship is to be 35 years.

3.1 Life Cycle Considerations. The ships are to be manned, if at all, by a Navy crew to be as small as practicable, but in any event not to exceed 50 people.

The ship shall be ready to perform its missile launch mission when called upon. Availability is the measure of readiness selected for the ship systems. The ship shall be designed, constructed, and integrated with a total ship inherent availability goal of 0.95.

Equipment and material selection, equipment arrangement, built-in-test equipment, redundancy, equipment reliability, manning, logistics facilities, transportation, replenishment, on-board storage, training, and use of off-board support teams and spares pools are to be developed so as to minimize life cycle cost. The maintenance concept shall be developed to achieve the availability goals but a a minimal life cycle cost. The maintenance concept shall be consistent with the Forward Operating Base Concept of the CONOPS.

Material selection, equipment arrangement, built-in-test equipment, redundancy, equipment reliability, manning, logistics facilities, transportation, replenishment, on-board storage, training, and use of off-board support teams and spares pools are to be developed so as to minimize operating and support (O&S) costs and be consistent with the CONOPS.

3.2 Buoyancy and Stability. The Ship is to have sufficient reserve buoyancy and stability to withstand flooding as a result of underwater damage. The ship is to withstand grounding or weapons damage that causes a leakage length of 15% of the hull waterline length, assuming the worst combination of flooded and non-flooded compartments within the overall damaged length. The undamaged ship is to have adequate stability to withstand the effects of 100 knot winds and accompanying seas. Stability is to be satisfactory both in full load departure and light load returning condition.

3.3 Design and Building Margins and Service Life Reserves.

Design and Building Margins are the responsibility of the offeror.

Service Life Reserves are ship and system capacities in the ship as completed that allow the ship to accept normal growth, planned and unplanned, during fleet service. The following margins are goals for service life of the ship after fleet acceptance of the Arsenal Ships:

- 20% electric power reserves
- 20% air conditioning capacity reserves
- 10% full load displacement growth
- 1 ft of full load center of gravity rise

The Service Life Reserves are exclusive of any margins for items specifically identified as space and weight capabilities.

3.4 Regulatory Capabilities. The ship design is to comply with 1972 COLREGS for-International-Inland and shall satisfy all the capabilities necessary to obtain certification for transit of the Suez Canal and Panama Canal. Rules-of-the-road equipment may be retracted or covered during low signature military operations.

3.5 Standardization. Standardization philosophy is be to maximize system performance at the lowest life cycle cost while achieving commonality with current Navy systems wherever possible.

3.6 Fuel. The propulsion plant and ship service auxiliaries is to be designed to use Diesel Fuel Marine (DFM), corresponding to NATO Code F-76.

3.7 Electric Plant Subsystem. The ship service generating units are to be of a rating and number such that with one unit inoperable, the remaining installed capacity are able to carry the worst case electric load. At least two sources of electric power are to be provided to all mission critical components.

3.8 Underway Replenishment. The ship is to be able to be refueled while underway from standard Navy auxiliary ships. Vertical replenishment of provisions is required. Re-arming of VLS cells at sea is not required.

3.9 Aviation Support. The ship is to be provided with helicopter facilities that meet day and night operations, Visual Meteorological Conditions, landing area with limited service facilities certification for SH-60, V-22 and CH-46 aircraft.

3.10Environment. The ship is be capable of operating between latitudes of 70° North and 60° South. The ships shall not be operated in pack ice. All equipment and machinery installed in exposed locations are to retain full system capability in -40° F to 120° F air temperatures with simultaneous winds up to 40 knots true. All ship systems are to retain full system capability in 28° F to 95° F sea temperatures. All ship systems are to retain full capability with external relative humidity of 0% to 100%.

3.11Machinery Rating Temperatures. Rated propulsion power and electric capacity shall be available with 100° F air temperature at prime mover inlet(s).

3.12Performance in a Seaway. The ship is to meet the following capabilities:

1. Sea state 5: replenish and strikedown underway
2. Sea state 6: continuous efficient operation (other than replenishment)
3. Sea state 7: limited operation, and capability of continuing its mission without returning to port for repairs after the sea subsides
4. Sea state 8 and above: survivability without serious damage to mission-essential systems.

All structure and fittings are to be designed to withstand dynamic forces produced by motion of a ship in a seaway without operation of any ship stabilization system

3.13Environmental Loading. Environmental loading for ship, ship structure, and exposed equipment for design purposes are as follows:

1. Wind loading on vertical projected area, 30lb./sq. ft.
2. Snow and ice loading on horizontal projected area, 7.5lb./sq. ft.
3. Wave slap load on equipment expected to be exposed to green water, 500lb./sq. ft.

3.14Pollution Control. The ship is to meet all applicable Federal and International environmental regulations.

3.15Personnel and Equipment Safety. The ship is to be designed and constructed to meet internal airborne noise capabilities appropriate to a compartment's function. All installed equipment shall maintain operational effectiveness when exposed to electromagnetic fields as follows: 200v/m for topside mounted equipment, 10v/m for below decks equipment, and 3 Oersteds from below deck equipment. The installed equipment shall satisfy the capabilities for the prevention of Hazards of Electromagnetic Radiation to Personal (HERP) and Ordnance (HERO). The installed equipment shall satisfy the capabilities for the prevention of Hazards of Electromagnetic Radiation to Personnel (HERP) and Ordnance (HERO).

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OCT 24 1996

MEMORANDUM OF LAW

SUBJECT: Scope of Section 845 Prototype Authority

Section 845 of the National Defense Authorization Act for fiscal year 1994[1] authorized the Defense Advanced Research Projects Agency (DARPA) to conduct prototype projects of weapons or weapons systems under the authority of 10 U.S.C. § 2371. Section 804 of the fiscal year 1997 National Defense Authorization Act[2] amended section 845 extending the authority to the Military Departments and other Department of Defense components. It also extended the authority until 1999. This memorandum reviews the background, purpose and scope of the statute. It is intended to aid in considering whether a project is a candidate for execution using section 845 and contains a preliminary discussion on the implications of utilizing the authority.

Background

In June 1986 the President's Blue Ribbon Commission on Defense Management (Packard Commission) made its final report to the President. Among the distinguished members of the Commission was Dr. William J. Perry the current Secretary of Defense. The summary final report contained these findings:

All too often, requirements for new weapon systems have been overstated. This has led to overstated specifications, which has led to higher cost equipment. Such so-called goldplating has become deeply embedded in our system today. The current streamlining effort in the Defense Department is directed at this problem.

Developmental and operational testing have been too divorced, the latter has been undertaken too late in the cycle, and prototypes have been used and tested far too little.

In their advanced development projects, the Services too often have duplicated each other's efforts and disfavored new ideas and systems. The Defense Advanced Research Projects Agency has not had a sufficient role in hardware experimentation and prototyping.[3]

Corollary recommendations were also contained in the report. They were:

Rather than relying on excessively rigid military specifications, DoD should make greater use of components, systems, and services available "off the shelf" It should develop new or custom-made items only when it has been established that those readily available are clearly inadequate to meet military requirements.

A high priority should be given to building and testing prototype systems and subsystems before proceeding with full-scale development. This early phase of R&D should employ extensive informal competition and use streamlined procurement processes- It should demonstrate that the new technology under test can substantially improve military capability, and should as well provide a basis for making realistic cost estimates prior to a full-scale developmental decision. This increased emphasis on prototyping should allow us to "fly and know how much it will cost before we buy."

The proper use of operational testing is critical to improving the operations performance of new weapons. We recommend that operational testing begin early in advanced development and continue through full-scale development, using prototype hardware. The first units that come off the limited-rate production line should be subjected to intensive operational testing and the systems should not enter high-rate production until the results from these tests are evaluated.

To promote innovation, the role of the Defense Advanced Research Projects Agency should be expanded to include prototyping and other advanced development work on joint programs and in areas not adequately emphasized by the Services.[4]

DARPA's charter was amended to include "a greater emphasis on prototyping in defense systems by conducting prototype projects ... and, on request, assist the Military Departments in their own prototyping programs."[5]

Prototyping is not new to DARPA. Prime examples include the Pegasus launch vehicle which transitioned directly into operational use. In fact, the first operational launches for the Air Force were conducted under the same contract DARPA had used in the development effort and which was transferred to and modified by the Air Force. Ceramic armor kits for Marine light armored vehicles were prototyped and operationally tested during the Gulf War on seventy-six vehicles. Perhaps the most famous example of DARPA prototyping dates back to 1961 when a DARPA sponsored test program fielded one thousand AR- 15 rifles in Southeast Asia for six months. The AR- 15 was the prototype of the M- 16.

Innovative R&D Agreements

Before discussing section 845, a review of the original "other transactions" authority is appropriate. Prior to 1989, the vast majority of DoD research and development contracting was conducted using procurement contracts as the funding

installment. The research offices of the Military Departments, particularly the Office of Naval Research, made significant use of grants. Other elements of DoD rarely, if ever, awarded research grants and there was no consensus within DoD as to the authority to award cooperative agreements. Under the existing DoD policies, grants were awarded only to academic institutions and non-profit research organizations.

In 1989 Congress enacted experimental authority for DARPA to conduct its research and technology development activities by "cooperative agreements or other transactions."[6] Cost sharing, though not absolutely required, was to be used if "practicable." The authority was available only if a "standard contract or grant" was not "feasible or appropriate." Later the authority was made permanent and extended to the Military Departments. Minor amendments have been made without substantive change on subsequent occasions, most recently in the fiscal year 1997 defense authorization. 8 DARPA made extensive use of this authority to conduct technology development efforts not subject to the procurement laws or regulations nor to the regulations governing standard grants and cooperative agreements.[9]

DARPA has found many occasions for using "other transactions" to support science and technology projects. These have included multi-party consortium agreements; agreements for the purpose of establishing standards, reference architecture, or common interfaces; transitioning technology into use; establishing industrial capabilities; technology development agreements with commercial firms, as well as combinations of these or other objectives.

Congress has endorsed DARPA's use of 10 U.S.C. § 2371 on several occasions in committee reports. Most recently, the conference report for the fiscal year 1997 authorization stated:

> The conferees direct the Services to follow the example of the Defense Advanced Research Projects Agency in the aggressive use of this authority under section 2371.[10]

There is no definition of an "other transaction." In a sense an "other transaction" is defined in the negative. It is not a standard procurement contract, grant or cooperative agreement. Thus, it is not subject to laws, rules and regulations that govern those instruments. Under 10 U.S.C. § 2371, "other transactions" can be used to stimulate and support research and development and for other purposes but may not be used for the principal purpose of acquiring goods and services for the direct benefit or use of the Federal Government.

Projects conducted under 10 U.S.C. § 2371 have typically, but not exclusively, supported dual-use technology developments or technologies with both military and civil applications. Industry's incentive to commercialize the technology serves as the rationale for cost-sharing and reduced government oversight. Cost-sharing and the limitation on the

transaction's principal purpose being to acquire goods and services greatly reduces the utility of 10 U.S.C. § 2371 for the acquisition of military systems.

Prototype Project Authority

After nearly three years of experience using 10 U.S.C. § 2371 to conduct cost-shared, dual-use technology development projects, a floor amendment to the fiscal year 1994 National Defense Authorization Act, extended DARPA's "other transactions" authority to prototype projects of weapons systems. The text of that amendment was:

> AUTHORITY OF THE ADVANCED RESEARCH PROJECTS AGENCY TO CARRY OUT CERTAIN PILOT DEMONSTRATION PROJECTS AND PROTOTYPE PROJECTS.
>
> (a)Authority. --The Director of the Advanced Research Projects Agency may, under the authority of section 2371 of title 10, United States Code, carryout pilot technology demonstration projects and prototype projects that are directly relevant to weapons or weapon systems proposed to be acquired or developed by the Department of Defense.
>
> (b) Exercise of Authority. --(I) Subsections (d)(2) and (d)(3) of such section 2371 shall not apply to pilot projects carried out under subsection (a).
>
> (2) The Director shall, to the maximum extent practicable, utilize competitive procedures when entering into agreements to carry out projects under subsection (a).
>
> (c) Period of Authority. --The authority of the Director to carry out projects under subsection (a) shall terminate 3 years after the date of-the enactment of this Act."

The following colloquy related to the amendment constitutes the principal legislative history of the measure:

Mr. BINGAMAN. Mr. President, the amendment which I am offering would allow the Advanced Research Projects Agency to use cooperative agreements authority on a pilot basis to execute some of its defense projects. ARPA already has the authority to use cooperative agreements and other transactions to implement its dual-use projects, where industry contributes its own resources and use of contracts would not be appropriate. Indeed, ARPA expects to utilize that authority extensively to implement the programs under the Technology Reinvestment Project.

My amendment would permit ARPA on a pilot basis over the next 3 years to experiment with use of cooperative agreements in carrying out its purely military research and development projects, to which we should not expect industry to contribute its own

resources. Use of this more flexible authority is consistent with the thrust of the National Performance review which the Vice President submitted to the President yesterday and with the desire for more flexibility in the defense acquisition system. ARPA led the way in use of cooperative agreements for dual-use projects, such as the high performance computing program. I am sure the agency will make good use of this new authority and urge my colleagues to support this amendment.

Mr. NUNN. This amendment allows ARPA to use the authority in section 2371 of title X, U.S.C. to carry out pilot projects that are directly relevant to weapon or weapons systems. This amendment will allow ARPA to use the cooperative agreements for purely military research as a 3-year test.

The PRESIDING OFFICER. The chair, hearing no further debate, without objection, the amendment offered on behalf of the Senator from New Mexico [Mr. Bingaman] is agreed to.

The amendment (No. 802) was agreed to.

Mr. NUNN. Mr. President, I move to reconsider the vote by which the amendment was agreed to.

Mr. WARNER. I move to lay that motion on the table. The motion to lay on the table was agreed to. [12]

As finally enacted the text of the statute reads as follows:

"(a) Authority.--The Director of the Advanced Research Projects Agency may, under the authority of section 2371 of title 10, United States Code, carry out prototype projects that are directly relevant to weapons or weapon systems proposed to be acquired or developed by the Department of Defense.

"(b) Exercise of authority.--(I) Subsections (c)(2) and (c)(3) of such section 2371, as redesignated by section 827(b)(1)(B), shall not apply to projects carried out under subsection (a).

"(2) The Director shall, to the maximum extent practicable, use competitive procedures when entering into agreements to carry out projects under subsection (a).

"(c) Period of authority.--The authority of the Director to carry out projects under subsection (a) shall terminate 3 years after the date of the enactment of this Act. [13]

The text of this version is virtually identical to the original amendment except for technical changes in subsection (b) and the deletion of the words "pilot technology demonstration projects and" before "prototype" in subsection (a). It is clear that no substantive change was intended by the wording change. Indeed the House report on the

provision of the current authorization Act which amends section 845 states: "This section would reauthorize and expand to the military services the authority provided by section 845 of the National Defense Authorization Act for Fiscal Year 1994 (Public Law 103-160) to allow additional flexibility in the acquisition of prototype technologies and systems."[14]

Section 804 of Public Law No. 104-201 reads as follows:

SEC. 804. MODIFICATION OF AUTHORITY TO CARRY OUT CERTAIN PROTOTYPE PROJECTS

(a) Authorized Officials. (1) Subsection (a) of section 845 of the National Defense Authorization Act for Fiscal Year 1994 (Public Law 103-160; 107 Stat. 172 1; 10 U.S.C. 2371 note) is amended by inserting ", the Secretary of a military department, or any other official designated by the Secretary of Defense" after "Agency".

(2) Subsection (b)(2) of such section is amended to read as follows:

"(2) To the maximum extent practicable, competitive procedures shall be used when entering into agreements to carry out projects under subsection (a).".

(b) Extension of Authority. Subsection (c) of such section is amended by striking out "terminate" and all that follows and inserting in lieu thereof "terminate at the end of September 30, 1999.".

(c) Conforming and Technical Amendments. Section 845 of such Act is further amended (1) in subsection (b)

(A) in paragraph (1), by striking out "(c)(2) and (c)(3) of such section 2371, as redesignated by section 827(b)(1)(B)," and inserting in lieu thereof "(e)(2) and (c)(3) of such section 2371 "; and

(B) in paragraph (2), by inserting after "Director" the following: Secretary, or other official"; and

(2) in subsection (c), by striking out "of the Director".

Subsection (e)(2) and (e)(3) of 10 U.S.C. 237 1, as amended, are the provisions on cost sharing and limiting use of non-procurement agreements to situations where standard contracts, grants or cooperative agreements are not feasible or appropriate. Both provisions are inapplicable to section 845 agreements.

Expanded Authority

As amended by section 804 of the fiscal 1997 Authorization Act, subsection (a) of 845 now reads as follows:

> (a) Authority.-- The Director of the Defense Advanced Research Projects Agency, the Secretary of a military department, or any other official designated by the Secretary of Defense may, under the authority of section 2371 or title 10, United States Code, carry out prototype projects that are directly relevant to weapons or weapons systems proposed to be acquired or developed by the Department of Defense."[15]

The authority flows directly to the Director of DARPA, secretaries of military departments, and the Secretary of Defense. Secretaries of military departments may delegate the authority within their departments. The Secretary of Defense may designate other officials (such as Directors of Defense agencies) to exercise the authority. Thus, the authority is potentially available to all elements of the Department of Defense. This is, of course, extremely important to DARPA. In many cases DARPA prototype projects win be conducted jointly with another Department of Defense component and at some point DARPA will want to transition the project to the ultimate user (e.g., the Air Force in the case of high altitude unmanned aerial vehicles, or the Navy in the case of Arsenal Ship). This is now possible. Furthermore, DARPA-funded prototype projects can now be contracted entirely through a Service contracting agent or through another DoD component designated by the Secretary of Defense.

Appropriate Uses of Section 845

Section 845, as amended, authorizes non-procurement agreements ("cooperative agreements and other transactions") to "carry out prototype projects that are directly relevant to weapons or weapons systems proposed to be acquired..... Section 845's grant of authority is bounded by the definition of "prototype projects" and "weapons or weapons systems proposed to be acquired."

A principal canon of statutory construction is to apply the plain meaning to words. The standard dictionary classifies "prototype" as a noun and defines it as "an original model on which something is patterned" and also as "a full-scale and (usually] functional form of a new type or design of a construction (as an airplane)."[16] the engineering definition of prototype is "[@] model suitable for use in complete evaluation of form, design and performance."[17]

The same conference report which contains the amended section 845 language contains numerous references to "prototypes" such as: "component prototypes for insertion into current undersea weapons"; "operational prototype"; "advanced technology "flyable prototype"; "JASS high band prototype"; 1. prototype prototype improvements"; ground-based radar"; "prototype plant."" Clearly Congress is aware that the term "prototype" is used in a wide variety of contexts including its dictionary definitions. However, the authority to conduct projects involving "full-scale," "functional,"

"operational" or "pre-production" prototypes does not limit the authority to conduct projects of lesser scope such as technology demonstrations, sub-system or component prototypes. As noted above, the original version of section 845 expressly included "pilot technology demonstration projects." Furthermore, the legislative history of the amendment to section 845 refers to "additional flexibility in the acquisition of prototype technologies and systems."[19] Thus, "prototype projects" under section 845 includes prototype "systems" but also includes lesser projects involving sub-systems, components, technology demonstrations and technologies.

The breadth of section 845 is also limited by the term "weapons or weapons systems." The statute does not define "weapons." Again, a common sense, plain-meaning approach should be used in interpreting this phrase. A useful reference n-tight be the United States Munitions List published by the Department of State .20 If the prototype project involves equipment of the types included on the Munitions List, it would be deemed to involve a "weapon." This is not a complete answer, however, since other items of equipment not included on the list may clearly fit the definition of a "weapon."

It should also be noted that the statute does not require that the prototype project be for the development of a weapon. The statutory requirement is for the project to be "directly relevant" to "weapons or weapon systems proposed to be acquired or developed..."[21] This emphasizes the point made above that sub-systems, components, and technologies are included in the scope of Section 845. Furthermore, this language is broad enough to include training, simulation, auxiliary and support equipment "directly relevant" to weapons or weapon systems."

From the plain meaning of its language, it is clear that the scope of section 845 is extremely broad. It would at least include the major categories of equipment contained in the U.S. Munitions list: firearms; ammunition; artillery projectors; launch vehicles, guided missiles, rockets, torpedoes, bombs and mines; explosive propellants and incendiary agents; vessels of war and special naval vessels; tanks and military vehicles; aircraft, spacecraft and associated equipment; military training equipment; protective personnel equipment; military and space electronics; fire control, range finder, optical and guidance and control equipment; auxiliary military equipment; toxicological agents and equipment and radiological equipment; nuclear weapons test and design equipment; and, submersible vessels, oceanographic and associated equipment. Weapons can be either offensive or defensive in character.

Given the trend toward utilizing off-the-shelf components and technologies in defense systems, section 845 prototype projects may often involve the adaptation, testing, or integration of commercial items for military purposes. Indeed it is interesting to note that the Packard Commission recommended greater use of "off-the-shelf' systems and components in the paragraph immediately preceding the recommendations on increased prototyping.[22] A significant "off-the-shelf" content does not preclude a prototype project from being conducted under section 845; indeed, in the future use of off-the-shelf technology, components and systems, as well as prototyping, will probably increase.

Furthermore, consistent with the Packard Commission recommendation quoted above, a prototype project could continue through initial low-rate production in order to support operational testing. 13

Finally, there is no reason to assume that 1. proposed to be acquired" means anything more than "if it works it may be the kind of thing we would buy." Certainly "proposed to be acquired" does not mean that a formal requirement has already been established. The purpose of DARPA has been defined as to "change people's minds." Thus a successful prototype may result in the creation of a requirement (e.g., HAVE BLUE). In 1991 Dr. Perry clarified the Packard Commission recommendation by stating that their purpose was not to insert DARPA into the formal acquisition process but to expand DARPA's role and have the Services act more like DARPA. Thus, prototype projects should not be limited to established requirements or already approved programs.

Effect of Section 845 - In General

Section 845, as amended, authorizes prototype projects to be conducted under the provisions of 10 U.S.C. 2371. Section 2371 in turn authorizes the use of "cooperative agreements and other transactions" for certain research and technology development efforts. Section 2371 efforts will be conducted using cost sharing "to the extent practicable." Section 845 is exempt from that proviso. Section 2371 efforts are authorized only if "a standard contract ... is not feasible or appropriate." Section 845 is also exempt from that requirement. Competition shall be used in section 845 to the maximum extent practicable.

DARPA has a five year history of interpretation and practical application of section 237 1. DARPA has made numerous reports to Congress on its use of the authority. In addition, Congress has received testimony at committee hearings, reports of the General Accounting Office, and other information on DARPA's use of both the basic 10 U.S.C. § 2371 authority and section 845 prototype authority. Congress has appropriated millions of dollars to DARPA for projects knowing that they were to be conducted using "other transactions." Statements in floor debate, as well as committee and conference reports, endorse DARPA's interpretation and use of this flexible authority. The interpretation of the effect of "other transactions" authority contained in this section may thus be viewed as ratified not only by Congressional statements but by Congress' act of appropriating millions of dollars in light of DARPA's application and interpretation of the statutes, and by Congress' reenactment of both 2371 and 845 with knowledge of DARPA's interpretation.[24]

"Other transactions" conducted under 10 U.S.C. 2371 and section 845 are transactions conducted outside the procurement laws and regulations and outside most laws and regulations applicable to assistance relationships. Laws of general applicability such as title VI of the Civil Rights Act,[21] the Trade Secrets-Act,[26] and Conflict of Interest statute[27] are applicable. Laws and regulations specifically applicable to the procurement system are not applicable. Among the laws not applicable are chapters 137, 14 1, and 144

of title 10, United States Code and title 48, Code of Regulations. Neither the Armed Services Procurement Act[28] or other principal procurement laws apply. The Federal Acquisition Regulation (FAR) and the Defense Acquisition Regulation Supplement (DFARS) do not apply. DoD regulations and Military Specifications and Standards applicable to the procurement system do not apply. A number of statutes not falling within the principal title 10 chapters governing procurement are clearly procurement statutes since they reference or use terms defined in chapters 137 or 144 (e.g. 10 U.S.C. 2362, 2365 and 2366).

Contracting under FAR and DFARS is subject to an extensive regulatory system. It might be worth briefly reviewing the 'impact of the procurement regulatory system at this point.

Professor Ralph C. Nash recently reported that a change in DFARS allowing submission of interim vouchers caused him to recall that a similar proposal had been rejected twenty-eight years ago:

> I remembered the incident because I used it in teaching for many years - as an illustration of the idiosyncrasies of Government procurement. After describing the proposal, which had been made by an industry association, THE GOVERNMENT CONTRACTOR, in 1968, described the outcome as follows:
>
> > After reviewing this proposal, the ASPR (Armed Services Procurement Regulation] Committee observes that - although prior DCAA review is in many cases "perfunctory and therefore unnecessary" - it is nevertheless a control which "should not be lightly discarded." Moreover, it does not appear to the Committee that DCAA reviews cause any significant delay in invoice payment. Accordingly, the Committee has decided not to adopt the proposed procedure.
>
> I always liked this description because it seemed to say something about how the regulatory mind worked. It may be "perfunctory and unnecessary" but it looks good and only does a little harm! That's the regulatory process - an accumulation of hundreds of those critters.[29]

Management consultant Robert C. Spreng compared DoD RDT&E contract awards with the Business Week R&D scorecard and the Fortune 500 Industrials.[30] In addition to a startling concentration of RDT&E dollars in a very small number of firms, Spreng found that 95% of the industry/group leaders that invested the greatest percentage of their sales in R&D received insignificant or no DoD RDT&E awards." These firms were usually on the leading edge of technology developments in their industry. Also 70% of the firms that invested the most total dollars in R&D in their industry/group had insignificant or no DoD RDT&E awards.[32] These 39 leading firms invested $32 billion in R&D in 1993. According to Spreng "a significant share of the most valuable research and

product development activity in commercial companies is virtually unavailable to the Federal Government, despite potential benefits to both parties."[33] Spreng's conclusion is that: "Commercial firms will offer the government significantly more of the needed technologies, some right off the laboratory shelf, when the Government can make available adequate protection for commercially oriented intellectual property and the use of existing commercial accounting methods for R&D."[34]

Finally, Senator Jeff Bingaman has noted that our government procurement system is one that spends millions to save thousands.

The potential benefits of deregulating the government procurement system are enormous. Deregulation means firms which are unwilling or unable to comply with government rules can be included in government R&D programs. Billions of dollars in privately funded R&D can be leveraged. Government regulations and procedures that do not add value to the process can be abandoned. Contracting techniques can be tailored to take advantage of available opportunities on a case by case or technology by technology basis.

"Other transactions" permit a deregulation of the government R&D system. Existing rules and regulations can be ignored or applied by agreement on a selective basis if deemed to add value. The essence of this non-regulatory system is the principle of freedom of contract.

Freedom of contract should not be a frightening concept. It is the concept upon which the Sales Article (Article II) of the Uniform Commercial Code, as well as many other articles of the Code, is based.[35] The U.C.C. sets up a baseline of rules which apply unless the parties agree otherwise.[36] Under "other transactions" even the baseline is absent and the parties are confronted with a clean slate. DARPA's experience has found that a model agreement expedites the negotiation process by serving as an initial baseline. Likewise use of the model as a baseline facilitates the agreement review process.

As a final note, it is worth pointing out that a non-regulatory system is not unprecedented. Alternative authority to buy experimental and prototype systems without regard to the Armed Services Procurement Act "by contract or other-wise" exists at 10 U.S.C. 2373. That provision has been rarely if ever used perhaps exactly because there is no regulatory coverage in FAR. There is no government-wide requirement for the issuance of regulations as a precondition for entering into government contracts. [37]

If the Department of Defense or the Military Departments issue regulations on "other transactions" in the future, they should be baseline guidance embodying the freedom of contract principle and not regulatory mandates.

Effect of Section 845 - Selected Issues

Competition to the maximum extent practicable is a statutory requirement of prototype projects conducted under section 845. The requirement is not an absolute but obviously by using the term "maximum extent," Congress has made a strong policy statement in favor of competition. The requirement is tempered by the practicability standard. There should be a well documented rationale for initiating section 845 projects in the absence of competition. The statute does not specify the type or characteristics of the competition. Thus, there is plenty of room to introduce innovative forms of competition in prototype projects. The competition can be modeled on the competitive proposal procedures of FAR 6.102(b) and FAR Part 15 or the broad agency announcement (BAA) technique authorized by FAR 6.102(d)(2) and FAR 35.016. Under the FAR, a BAA would normally not be used for a weapons systems prototype development, but under section 845 it can be. Furthermore, entirely new forms of competition can be utilized. Combinations of proposals and oral presentations could be used. Final award selection can be made only after the agreement(s) have been negotiated in final form. Specially tailored techniques can be adopted for special circumstances. Note that the Packard Commission recommended "informal competition."[38]

During the competition phase of a prototype project a procedure for handling objections or "protests" should be developed and made known to the competitors. This is necessary because the General Accounting Off-ice protest systems applies only to procurements conducted under the procurement statutes.[39] The GAO w inquire into whether a non-procurement instrument was properly used. If it finds use of a non-procurement instrument proper, GAO has no further role. A protester can always go to court but the court's review is based on the Administrative Procedure Act.[40] This essentially requires the plaintiff to show that the Government’s action was arbitrary, capricious, an abuse of discretion or unlawful.[41] Since relatively few laws apply to section 845 actions, review would typically be focused on whether the action taken by the Government was arbitrary, capricious or an abuse of discretion.

Socio-economic policies implemented specifically through the procurement system do not apply to section 845 projects. For example in the area of equal opportunity while title VI of the Civil Rights Act, applicable to any Federal program applies, Executive Order 11246, applicable to procurement contracts, does not.

As noted by the comments of Robert Spreng, government-required accounting rules and cost principles cause many firms to avoid government R&D contracts. Government-required accounting and purchasing systems are often costly and labor intensive. In the long run the government itself pays for these systems but their initial cost is a serious barrier for commercial firms considering seeking government contracts. Under section 845, there is no requirement to Implement government systems. In fact, cost reimbursement contracting is a rarity in private contracting. DARPA is experimenting with making payment based on technical progress rather than for incurred costs, as well as using multi-factor positive and negative incentives. This is another area open for innovation.

Another major concern of private industry is the protection of intellectual property. Neither the rights in technical data provisions of tide 10, U.S. Code nor the Bayh-Dole Act[42] governing patent rights are applicable to "other transactions" under section 845 thus the government can agree to intellectual property rights tailored to each project.

The Procurement Integrity Act (41 U.S.C. 423) applies only to procurement actions not to "other transactions," however, government employees who are involved in source selection, handling sensitive information, and making programmatic decisions are still subject to 18 U.S.C. 1905 (relating to trade secrets and sensitive business 'information) and 18 U.S.C. 208 (relating to conflicts of interest). Furthermore, the practice at DARPA has been to have all personnel, whether government or non-government, who have access to source selection and sensitive information sign non-disclosure agreements, submit financial disclosure forms, and sign statements concerning their relationships with competitors. False statements are, of course, subject to the provisions of 18 U.S.C. 1001.

Many prototype projects involving systems will be conducted with a view toward an eventual decision to go into production. Although the statutes governing survivability, lethality, operational and other test requirements do not apply to section 845 projects, they nonetheless serve as indications of the type of information which a prototype project should generate in order to support a decision to go into production. Section 845 prototype projects should be planned to address test issues in a manner functionally equivalent to statutory test requirements, while avoiding unnecessary bureaucracy and non-value added documentation.

Current legal authority under section 845 does not extend to full-scale production. If it is intended to transition a system from a prototype project directly into production, the project will have to generate, in addition to survivability and operational test data, life cycle cost and other data sufficient to support a special Defense Acquisition Board, or other authorized review, prior to a production (Milestone III) decision.

If a section 845 systems project involves innovative business and contracting practices, advanced planning must be done to obtain appropriate waivers and exemptions for business practices that will be carried over to the production program. This might include having the project designated a pilot acquisition program in order to obtain expanded waiver authority.

Obviously both program decision-making and production contracting would be greatly facilitated by additional statutory authority allowing an approved section 845 prototype project to transition directly into production on the same contracting basis upon which the prototype project was conducted. DARPA is seeking just such legislative authority.

Conclusion

Section 845 prototyping authority allows for flexibility and innovation in military systems development projects as well as in technology demonstrations and prototyping of subsystems and components. It should allow traditional defense contractors to consider new ways of doing business and permit strictly commercial firms to do business with DoD without changing their existing business practices. Section 845 moves away from an R&D regulatory system to freedom of contract. This is both a challenge and an opportunity. Suggestions on effective ways to implement this new authority are welcomed and should be addressed to the undersigned at the address on the letterhead.

Richard L. Dunn
General Counsel

END NOTES

[1] National Defense Authorization Act for Fiscal Year 1994, Pub. L. No. 103-160, 107 Stat. 1547 (1993).
[2] National Defense Authorization Act for Fiscal Year 1997, Pub. L. No. 104-201, 1 10 Stat. 2422 (1996).
[3] PRESIDENT'S BLUE RIBBON COMMISSION ON DEFENSE MANAGEMENT, FINAL REPORT (1986)(reprinted in DEFENSE ACQUISITION: MAJOR U.S. COMMISSION REPORTS (1949-1988) vol. I, Committee on Armed Services U.S. House of Representatives (100th Cong., 2d Sess., Nov. 1, 1988), 878) (hereinafter referred to as the Packard Commission).
[4] Id. at 880-881.
[5] 32 C.F.R. Part 358 (1989); DODD 5105.41 (Jan. 25, 1989).
[6] National Defense Authorization Act for FY90-9 1, Pub. L. No. 10 I - 1 89, § 251, 103 Stat. 1352 (1989) (codified as amended at 10 U.S.C. § 2371 (1996)).
[7] National Defense Authorization Act for FY92-FY93, Pub. L. No. 102-190, § 826, 105 Stat 1290 (1991) (codified as amended at 10 U.S.C. § 2371 (1996)).
[8] National Defense Authorization Act for Fiscal Year 1997, Pub. L. No. 104-201, § 267, 1 10 Stat. 2422 (1996) (codified as amended at 10 U.S.C. § 2371 (1996)).
[9] For information on DARPA's use of this authority, see also UNITED STATES GENERAL ACCOUNTING OFFICE, PUB. No. NSIAD-96-1 1, DOD RESEARCH - ACQUIRING RESEARCH BY NONTRADITIONAL MEANS (Mar. 1996); DEPARTMENT OF DEFENSE INTEGRATED PROCESS TEAM, THE SERVICES USE OF 10 U.S.C. § 2371 "OTHER TRANSACTIONS" AND § 845 PROTOTYPE AUTHORITIES, FINAL REPORT (1996); MICHAEL S. NASH, ET AL., INSTITUTE FOR DEFENSE ANALYSES, PUB. No. D- 1793, PARTICIPANT VIEWS OF ADVANCED RESEARCH PROJECTS AGENCY "OTHER TRANSACTIONS," (1995); Richard N. Kuyath, *The Untapped Potential of the Department of Defense's "Other Transaction " Authority*, 24 Pub. Con. L. J. 521 (Summer 1995); Richard L. Dunn, Testimony before the United States House of Representatives Committee on

Science (Nov. 8, 1995) (transcript available from the United States Government Printing Office).
[10] 142 Cong. Rec. H9249 (daily ed. July 30, I 996).
[11] 139 Cong. Rec. S 1 1158, S 1 1296 (daily ed. Sept. 9, 1993).
[12] 139 Cong. Rec. S I 1 158, S 1 1288 (daily ed. Sept. 9, 1993).
[13] National Defense Authorization Act for Fiscal Year 1994, Pub. L. No. 103-160, 107 Stat. 1547 (1993).
[14] H. R. REP. No. 563, 104th Congress, 2nd Sess., 325-326 (1996).
[15] Section 845, Pub. L. No. 103-160 as amended by section 804 Pub. L. No. 103-160.
[16] WEBSTER'S NINTH NEW COLLEGIATE DICTIONARY 947 (1985).
[17] McGRAW-HILL DICTIONARY OF SCIENTIFIC AND ENGINEERING ARMS I 1 83 (1974).
[18] H.R. REP. No. 724, 104th Cong., 2nd Sess. (1996).
[19] H.R. REP. No. 563, 104TH CONG., 2ND SESS. 326 (1996).
[20] 22 C.F.R. § 121.1 (1994).
[21] National Defense Authorization Act for Fiscal Year 1994, Pub. L. No. 103-160, § 845, 107, Stat 1547 (1993), as amended by the National Defense Authorization Act for Fiscal Year 1997, Pub. L. No. 104-201, § 267, 1 10 Stat. 2422 (1996).
[22] Packard Commission.
[23] *Id*.
[24] T.V.A. v. Kinzer, 142 F. 2d 833, 837 (6th Cir. 1944) ("The voting of such appropriations, in the face of the construction placed upon the Act by the Authority, has an effect similar to that resulting from reenactment of a statute the provisions of which had, theretofore, been interpreted ... they are deemed to have received legislative ratification, and thereby, to have become embedded in the law.") See also U.S. v. Two Tracts of Land, 456 F. 2d 264 (6th Cir.), cert. denied, 409 U.S. 887 (1972).
[25] 42 U.S.C. § 2000(d) (1964).
[26] 18 U.S.C. § 1905 (1992).
[27] 18 U.S.C. § 208 (1994).
[28] 10 U.S.C. Chapter 137.
[29] Ralph C. Nash, Payment Procedures: Processing of Interim Vouchers, 10 Nash & Cibinic Report ¶47 (Sept. 1996).
[30] ROBERT C. SPRENG, LEADING COMMERCIAL FIRMS SHUN DOD AND R&D (1994).
[31] *Id*.
[32] *Id*.
[33] *Id*. at 3.
[34] *Id*. at 3.
[35] U.C.C. § I- 102(3) (1962).
[36] {T}he idea of flexibility in contracting is embedded in contract theory. Most analyses of commercial contract law simply assume that flexibility exists and should be fostered.... The idea that parties are free to choose terms can be justified in a number of ways. It leads to a preference for laws that provide background rules, playing a default or gap-filling function in a contract relationship. A default rule applies if the parties do not agree to the contrary . . . . The second commercial law promise ... is approached ... by an effort to identify

existing patterns of commercial practice and to follow a presumption that the goal of the drafting is to identify, clarify and, where needed, validate existing patterns of contracting to the extent that these are not inconsistent with modern social policy .... Uniform contract laws do not regulate practice. They seek to sustain and facilitate it. The benefits ... lie in defining principles consistent with commercial practice which, because of their codification and their relevance to actual practice, can be relied on and are readily discernible and understandable to commercial parties." National Conference on Commissioners on Uniform State Laws, Uniform Commercial Code, Article 2B. Licenses ix-x (Dec. 1, 1995) (Draft available from the National Conference on Commissioners on Uniform State Laws).

[37] 5 U.S.C. § 553(a)2) (1966).

[38] Packard Commission.

[39] Energy Conversion Devices, B-260514, June 16, 1995, 95-2 CPD 1121.

[40] 5 U.S.C. §§ 701-706 (1994). See also Scanwell Laboratories v. Schaffer, 424 F.2d 859 (D.C. Cir. 1970).

[41] 5 U.S.C. § 706 (1994).

[42] 35 U.S.C. Chapter 18 (1982).

This Memorandum of Law modifies and supersedes a memorandum for internal DARPA distribution on the same subject dated September 27, 1996.

THE UNDER SECRETARY OF DEFENSE
3010 DEFENSE PENTAGON
WASHINGTON, DC 20301-3010

DEC 14 1996

MEMORANDUM FOR SECRETARIES OF THE MILITARY DEPARTMENTS
DIRECTORS OF DEFENSE AGENCIES

SUBJECT: 10 U.S.C. 2371, Section 845, Authority to Carry Out Certain Prototype Projects

Section 845 of the National Defense Authorization Act for Fiscal Year 1994, Public Law 103-160, authorizes the Director of DARPA to enter into transactions (other that contracts) under 10 U.S.C. 2371, for certain prototype projects. The authority under section 845 was to terminate November 30, 1996. Section 804 of the National Defense Authorization Act for Fiscal Year 1997, Public Law 104-201, extends the authority of section 845 through September 30, 1999, and makes it available to the Secretaries of the Military Departments and any other official designated by the Secretary of Defense. The Secretary of Defense delegated his authority and assigned his responsibilities, under the amendments made to section 845 by section 804, to me. I designate the Directors of the Defense Agencies as having the authority to use section 45 as authorized by subsection 804(a).

Section 845 authorizes use of instruments that are alternatives to contracts for the covered prototype projects. Section 845 requires, to the maximum extent practicable, use of competitive procedures when entering into "other transactions." To the extent that a particular statute or regulation is limited in its applicability to the use of a contract, it would generally not apply to an "other transaction." Attachment 1 is a list of statutes that apply to procurement contracts, but thatare not necessarily applicable to "other transactions." The list is provided for guidance only, and is not intended to be definitive. To the extent that a particular requirement is a funding or program requirement or is not tied to the type of instrument used, it would generally apply to an "other transaction." Each statute must be looked at to assure it does or does not apply to a particular funding arrangement using an "other transaction." Use of section 845 authority does not eliminate the applicability of all laws and regulations. Thus, it is essential that counsel be consulted when an "other transaction" will be used.

Section 845 may be used to carry out prototype projects that are directly relevant to weapons or weapon systems proposed to be

acquired or developed by the Department. When a prototype project, under the authority of section 845, is used as a precursor to a major defense acquisition program, I expect to be advised of the transition strategy for follow-on contracts at least 30 days prior to award of the "other transaction" that initiates the prototype project. The transition strategy must also address how the DoDD 5000.1 and DoD 5000.2R requirements will be applied to the acquisition process.

I believe it is essential that section 845 instruments incorporate good business sense and appropriate safeguards to protect the government's interest. This includes assurances that the cost to the government is reasonable, the schedule and other requirements are enforceable, and the payment arrangements promote on-time performance.

Annual congressional reporting requirements are established in 10 U.S.C. 2371(h), as modified by section 267 of Public Law 104-201. These requirements also apply to prototype projects under section 845. Each military department and defense agency using section 845 authority shall submit a report to OUSD(A&T)/DDP annually, by November 15, that includes all information required by 10 U.S.C. 2371 (h), and that summarizes section 845 lessons learned for each prototype project. The format and content for this submission are at Attachment 2. IN addition, users of section 845 may submit lessons learned at any time for inclusion in the Defense Acquisition Deskbook. The Deskbook will also be used to provide discretionary guidance and further information.

I encourage you to use the flexibility provided by this authority and to issue any further guidance you deem necessary. If you delegate authority to use section 845, I expect it will be to officials whose level of responsibility, business acumen, and judgment enable them to operate in this relatively unstructured environment. If we use this authority wisely, I will request that it be extended or made permanent by the Congress.

Paul Kaminski

Paul G. Kaminski

Attachments

STATUTES INAPPLICABLE TO "OTHER TRANSACTIONS"

1. Competition in Contracting Act, Pub. L. No. 98-369 (1984), as amended- Promotes the use of competitive procurement procedures and prescribes uniform government-wide policies and procedures regarding contract formation, award, publication, and cost or pricing data (truth in negotiations). See DoDD coverage generally at chapter 137 of title 10, United States Code, particularly sections 2301-2305.

2. Contract Disputes Act, Pub. L. No. 95-563 (1987, as amended, 41 U.S.C. 601 et seq.- Provides for the resolution of claims and disputes relating to government contracts.

3. Procurement Protest System, Subtitle D of Competition in Contracting Act, Pub. L. No. 98-369 (1984), 31 U.S.C. 3551 et seq. - Provides statutory basis for procurement protests by interested parties to the Comptroller General.

4. Public Law 85-804, 50 U.S.C. 1431-1435, Extraordinary contractual relief - Authorizes such remedies to contractors as formalization of informal commitments, amendments without consideration, and correction of mistakes, and permits indemnification for unusually hazardous risks.

5. 10 U.S.C. 2207. Expenditure of appropriations: limitation - Permits termination of contracts upon a finding that the contractor has offered or given gratuities to obtain a contract.

6. 10 U.S.C. 2306. Kinds of contracts - Prohibits use of cost-plus-a percentage-of-cost system of contracting; requires a covenant against contingent fees paid to obtain contracts; limits fee amount on virtually all cost-type contracts.

7. 10 U.S.C. 2313. Examination of records of contractor- Provides agency and GAO access to contractors facilities to audit contractor and subcontractor records and gives the DCAA subpoena authority.

8. 10 U.S.C. 2353. Contracts: acquisition , construction, or furnishing of test facilities and equipment (to R&D contractors).

9. 10 U.S.C. 2354. Contracts: indemnification provisions- Indemnification authority against unusually hazardous risks for R&D contractors.

10. 10 U.S.C. 2393. Prohibition against doing business with certain offerors - Prohibition with respect to solicitation of

offers and contract awards to contractors that have engaged or are suspected to have engaged in criminal, fraudulent, or seriously improper conduct.

11. 10 U.S.C. 2403. Major weapon systems; contractor guarantees.

12. 10 U.S.C. 2408. Prohibition on persons convicted of defense- contract related felonies and related criminal penalty on defense contractors - Generally, convicted felons precluded from working in a managerial capacity on DoD contracts.

13. 10 U.S.C. 2409. Contractor Employees: protection from reprisal for disclosure of certain information. Whistle blower protection to contractor employees.

14. 31 U.S.C. 1352. Limitation on the use of appropriated funds to influence certain Federal contracting and financial transactions - Prohibits use of funds to influence or attempt to influence government officials or members of Congress in connection with the award of contracts, grants, loans, or cooperative agreements.

15. Antikickback Act of 1986, 41 U.S.C. 51-58 - Prohibits kickbacks in connection with government contracts; provides civil and criminal penalties.

16. Procurement Integrity Act, section 27 of the Office of Federal Procurement Policy Act, 41. U.S.C. 423 - Imposes civil, criminal, and administrative sanctions against individuals who inappropriately disclose or obtain source selection information or contractor bid and proposal information.

17. Service Contract Act. 41 U.S.C. 351 et seq., Walsh Healy Act, 41 U.S.C. 35-45; Fair Labor Standards Act, 29 U.S.C. 201-219 - Provide protections for contractor employees.

18. Drug-Free workplace Act of 1988, 41 U.S.C. 701-707 - Applies to contracts and grants.

19. Buy American Act, 41 U.S.C. 10 a-d. Applies only in part to “other transactions.”

SECTION 845
ANNUAL REPORT REQUIREMENTS

Awarding Activity: Identify the military department or defense agency, a point of contact, and a phone number.

General Description: Provide a general description and discuss the objectives of the 845 prototype project, including the technology areas for which research is conducted.

Reasons for Use of 845 Authority: Explain the reason for choosing to use the 845 authority and address the expected benefits.

Extent of Cost-Sharing, if any: [Section 845 is exempt from the 10 USC 2371(E)(1)(B) requirement for cost-sharing.]

Technology and Industrial Base Implications: Discuss the extent the use of an "other transaction" (I) has contributed to a broadening of the technology and industrial base available for meeting DoD needs; and (ii) has fostered within the technology and industrial base new relationships and practices that support the national security of the United States.

Payments Received and Credited, if any: [10 USC 2371 (d) allows an "other transaction" to require payment to the Department as a condition for receiving support under an "other transaction" and permits any such payment to be credited to support accounts.]

Lessons Learned: Contrast the actual benefits or drawbacks experienced to the expected benefits discussed above, being as quantitative as possible, and provide any additional lessons learned. This section is not required by statute, but will be used to decide whether the Department should pursue extension of the authority prior to its expiration in 1999. This section should be updated annually and reported for all section 845 prototype projects until the prototype project is complete.

ADVANCED RESEARCH PROJECTS AGENCY
3701 NORTH FAIRFAX DRIVE
ARLINGTON, VA 22203-1714

April 14, 1997
Ser ASJPO/171

Dr. Michael Hughes
Lockheed Martin Corporation
P.O. Box 1027
MS 108-108
Moorestown, NJ 08057-0927

Dear Colleagues:

The joint Navy/DARPA Arsenal Ship Program Office has followed your team's Phase II activities with great interest. Your work to date has convinced us that: significant acquisition reform through the 845 Other Agreements Authority is achievable; that cooperative industry-government teaming to achieve CAIV and life cycle goals is producing the desired results; that your focus on minimum crew size with attendant cost of ownership implications is generating exciting designs; that your focus on ship survivability with design features of multiple hulls, automated damage control techniques, and signatures management will alter survivability philosophy significantly; and that your Arsenal Ship Demonstrator if selected,- will be a terrific vehicle to evaluate the concept of massed precision firepower in support of the Land Component Commander, within a joint warfighting context.

At the beginning of the Arsenal Ship Phase IV demonstration with the fleet, the Navy is planning on using the Arsenal Ship Demonstrator, in parallel with its primary tests to evaluate the military utility of the Arsenal Ship, to evaluate various SC-21 technologies. The ASJPO has determined that this testing can be accommodated within current demonstrator designs. This is an advisory message only, so that you are apprised of future plans for this Demonstrator. No changes in the design, goals, or evaluation criteria for downselect at the end of the current phase, are -intended.

The SC-21 technologies which require risk reduction at sea testing include:

- Advanced Integrated Electronic Warfare System (AIEWS),	EDM Available FY99
- ADCON-21,	EDM Available FY01
- Integrated Power System,	EDM Available FY01
- Advanced Human Computer Interface,	EDM Available FY01
- Multi Function Radar (X Band),	EDM Available FY02
- Lightweight Broadband Variable Depth Sonar Handling System	EDM Available FY03
- Volume Search Radar (L Band)	EDM Available FY03
- Vertical Gun for Advanced Ships (VGAS)	EDM Available FY04

Some or all of these may be tested on the Arsenal Ship Demonstrator.

Sincerely,

C.S. Hamilton
CAPT USN
Arsenal Ship Program Manager

ADVANCED RESEARCH PROJECTS AGENCY
3701 NORTH FAIRFAX DRIVE
ARLINGTON, VA 22203-1714

April 14, 1997
Ser ASJPO/ 169

Dr. Pat Barry
Electronic Sensors and Systems Division
Northrop Grumman Corporation
P.O. Box 1693
Baltimore, MD 21203

Dear Colleagues:

The joint Navy/DARPA Arsenal Ship Program Office has followed your team's Phase II activities with great interest. Your work to date has convinced us that: significant acquisition reform through the 845 Other Agreements Authority is achievable; that cooperative industry-government teaming to achieve CAIV and life cycle goals is producing the desired results; that your focus on minimum crew size with attendant cost of ownership implications is generating exciting designs; that your focus on ship survivability with design features of multiple hulls, automated damage control techniques, and signatures management will alter survivability philosophy significantly; and that your Arsenal Ship Demonstrator if selected, will be a terrific vehicle to evaluate the concept of massed precision firepower in support of the Land Component Commander, within a joint warfighting context.

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- Multi Function Radar (X Band),	EDM Available FY02
- Lightweight Broadband Variable Depth Sonar Handling System	EDM Available FY03
- Volume Search Radar (L Band)	EDM Available FY03
- Vertical Gun for Advanced Ships (VGAS)	EDM Available FY04

April 14, 1997
Ser ASJPO/l69

Some or all of these may be tested on the Arsenal Ship Demonstrator.

Sincerely,

C.S. Hamilton
CAPT USN
Arsenal Ship Program Manager

ADVANCED RESEARCH PROJECTS AGENCY
3701 NORTH FAIRFAX DRIVE
ARLINGTON, VA 22203-1714

April 14, 1997
Ser ASJPO/ 170

Mr. Tom Egan
ArShip 21 Team
4301 North Fairfax Dr.
Suite 525
Arlington, VA 22015

Dear Colleagues:

The joint Navy/DARPA Arsenal Ship Program Office has followed your team's Phase If activities with great interest. Your work to date has convinced us that: significant acquisition reform through the 845 Other Agreements Authority is achievable; that cooperative industry-government teaming to achieve CAIV and life cycle goals is producing the desired results; that your focus on minimum crew size with attendant cost of ownership implications is generating exciting designs; that your focus on ship survivability with design features of multiple hulls, automated damage control techniques, and signatures management will alter survivability philosophy significantly; and that your Arsenal Ship Demonstrator if selected, will be a terrific vehicle to evaluate the concept of massed precision firepower in support of the Land Component Commander, within a joint warfighting context.

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- Multi Function Radar (X Band),	EDM Available FY02
- Lightweight Broadband Variable Depth Sonar Handling System	EDM Available FY03
- Volume Search Radar (L Band)	EDM Available FY03
- Vertical Gun for Advanced Ships (VGAS)	EDM Available FY04

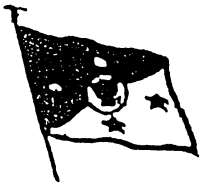
April 14, 1997
Ser ASJPO/l70

Some or all of these may be tested on the Arsenal Ship Demonstrator.

Sincerely,

C.S. Hamilton
CAPT USN
Arsenal Ship Program Manager

CHIEF OF NAVAL OPERATIONS



2 June 1997

Dear Mr. Chairman,

The four-year, twelve-ship DDG 51 proposal contained in the FY-98 President's budget offers a rare period of surface combatant program stability. At the same time, it has caused us to accelerate somewhat our normal timelines for out-year surface combatant SCN planning. In particular, the Congress has expressed interest in three areas: possible expansion of the multi-year to a thirteenth destroyer: the role of the Maritime Fire Support Demonstrator in transitioning to DD 21 (the surface combatant to allow the DDG 51 class(; the likelihood of a significant Aegis cruiser modernization effort. the purpose of this letter is to respond to this interest, while acknowledging many programmatic details have yet to be refined.

First, with respect to possible expansion of the DDG 51 multi-year proposal, we have included in our FY-98 budget request as many ships as our funding authority would allow. Clearly, the multi-year approach, when applied to a successful and mature program like DDG 51, contains substantial benefits and savings. Acceleration of an additional DDG 51 award into the multi-year window would increase the total savings while addressing validated surface combatant requirements. Before Congress authorized the multi-year buy, the average constant year cost for a single DDG 51 was $950M. The marginal cost of an additional DDG in FY-98 is $720M--substantially less than the other three ships in that year. I would welcome such action by the Congress.

Second, with respect to the Maritime Fire Support Demonstrator, we anticipate substantial benefit in terms of acquisition reform and technology advance swill accrue to DD 21, as well as CVX and future ships. Our partnership with DARPA and industry is producing results well beyond initial expectations. It was just this success that prompted us to expand the application of the original Arsenal Ship concept so we could capture more completely the advantage so this unique program. DD 21 must be a ship responsive both to twenty-first century requirements and fiscal limits. We are seeking revolutionary advances in joint connectivity and responsive, precise delivery of ordnance to realize our objective of offensive distributed firepower for the surface force. At the

same time, DD 21 must be affordable in the numbers needed to replace existing destroyers and frigates. If we do not break with historical norms of design, construction and life cycle costs, I am convinced we will not be able to build the right capability in the right numbers, at the right time. The Maritime Fire Support Demonstrator holds the key; I urge your active support for its continued funding.

With respect to modernization of the Aegis cruiser force; Quadrennial Defense Review deliberations revealed the need to perform a mid-life conversion of these superb ships. Our objective is to package Theater Ballistic Missile Defense (TBMD), Area Air Defense Commander, Land Attack and Smart Ship improvements into a class-wide upgrade, thereby assuring a preeminent role for Aegis cruisers into the third decade of the next century. This modernization program will enable otherwise unaffordable acceleration of TBMD and Land Attack introduction into our surface combatant force, while providing critical industrial work prior to full rate production of the DD 21. It is our intent to commence feasibility studies in FY-97 to permit and FY-98 modernization program start should congress make FY-98 funds available.

Together, the DDG 51 multi-year, Maritime Fires support Demonstrator, Aegis cruiser modernization and DD 21 programs will set the course for the surface navy of the next century. I look forward to working closely with you to ensure their success.

Sincerely,

JAY L. JOHNSON
Admiral, U.S. Navy

The Honorable Curt Weldon
Chairman, Military Research and Development
Committee on National Security
House of Representatives
Washington, DC 20515-3807

Copy to:
The Honorable Owen Pickett
Ranking Minority Member

The Honorable Duncan Hunter
2365 Rayburn House Office Building
House of Representatives
Washington, D.C. 20515-0552

The Honorable Ike Skelton
2227 Rayburn House Office Building
House of Representatives
Washington, D.C. 20515-2504

The Honorable Curt Weldon
2452 Rayburn House Office Building
House of Representatives
Washington, D.C. 20515-2507

The Honorable Owen Pickett
2263 Rayburn House Office Building
House of Representatives
Washington, D.C. 20515-4003

The Honorable Floyd Spence
2405 Rayburn House Office Building
House of Representatives
Washington, D.C. 20515-4002

The Honorable Ronald Dellums
2108 Rayburn House Office Building
House of Representatives
Washington, D.C. 20515-0509

The Honorable C.W. Bill Young
2407 Rayburn House Office Building
House of Representatives
Washington, D.C. 20515-0910

The Honorable John P. Murtha
2423 Rayburn House Office Building
House of Representatives
Washington, D.C. 20515-3812

The Honorable Bob Livingston
2406 Rayburn House Office Building
House of Representatives
Washington, D.C. 20515-1801

The Honorable Strom Thurmond
217 Senate Russell Office Building
United States Senate
Washington, D.C. 20515-4001

The Honorable John Warner
225 Senate Russell Office Building
United States Senate
Washington, D.C. 20510-4601

The Honorable Carl Levin
459 Senate Russell Office Building
United States Senate
Washington, D.C. 20510-2203

The Honorable Edward Kennedy
315 Senate Russell Office Building
United States Senate
Washington, D.C. 20510-2101

The Honorable Ted Stevens
522 Senate Russell Office Building
United States Senate
Washington, D.C. 20510-0201

The Honorable Daniel Inouye
722 Senate Russell Office Building
United States Senate
Washington, D.C. 20515-1102

DEPARTMENT OF THE NAVY
OFFICE OF LEGISLATIVE AFFAIRS
1300 NAVY, PENTAGON

IN REPLY REFER TO
LA-2:bj
October 24, 1997

MEMORANDUM FOR INTERESTED MEMBERS OF CONGRESS

Subj: MARITIME FIRE SUPPORT DEMONSTRATOR (MFSD)

1. Appreciating your interest in the current plans, policies, and programs of the Department of the Navy, please be advised that after reviewing Navy budget priorities, Secretary of the Navy John H. Dalton has reluctantly determined that insufficient funding exists to continue the next phase of the Maritime Fire Support Demonstrator (MFSD) program. The $35 million appropriated by Congress is not enough to enter the next phase of the MFSD development plan, which would include the award of a detailed design and construction contract in 1998. The Navy has reviewed and prioritized its programs and has determined that it is not possible to redistribute money from other areas to sustain the MFSD program. Reallocation of the $35 million appropriated by Congress is currently under review by the Navy.

2. The initial phases of the MFSD program provided a good return for the investment. these phases were highly successful in forming closer partnerships with industry as demonstrated by the teaming of combat system integrators and shipyards. the Navy is 100 percent committed to the fleet modernization that the MFSD program represented: teaming produced innovative concepts for modular integration of combat systems, improved ship survivability, design, radar signature reduction techniques, and reduced manning requirements. These innovations are directly transferable tot he Land Attack Destroyer (DD21). With the cancellation of the MFSD program, the Navy will lose the opportunity and the advantages of integrating these technologies into a single test platform at sea.

3. DD 21 development will continue as planned, using an acquisition strategy patterned after the MFSD. The program turns the systems development process over to industry teams at the earliest stage and challenges industry to develop and design the optimum mix of performance capabilities which can be accommodated within production and life-cycle affordability constraints. This approach has already produced several technological breakthroughs in the initial stage of MFSD development, and the Navy is confident that industry will deliver a revolutionary ship in DD 21.

4. Planned milestones for the DD 21 program include: December 1997 - Initiate Request for Proposals; March 1998 - Award multiple concept development contracts; 2004 - Award contract for the first DD 21.

Subj: MARITIME FIRE SUPPORT DEMONSTRATOR (MFSD)

5. The Office of Legislative Affairs point of contact is Commander Pete Gumataotao, USN, at (703) 695-1366.

Sincerely,

JAY M. COHEN
Captain, U.S. Navy
Deputy Chief of Legislative Affair

October 24, 1997 1600

Response to Query regarding
Maritime Fire Support Demonstrator

After reviewing Navy budge priorities, Secretary of the Navy John H. Dalton has reluctantly determined that insufficient funding exists to continue the next phase of the MFSD program. The Navy and DARPA jointly requested $150 million in FY 1998 for the MFSD program. The $35 million appropriated by Congress is not enough to enter the next phase of the MFSD development plan, which would include the award of a detailed design and construction contract in 1998. The Navy has reviewed and prioritized its programs and has determined that it is not possible to redistribute money from other areas to sustain the MFSD program. Reallocation of the $35 million appropriated by Congress is currently under review by the Navy.

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DD 21 development will continue as planned, using an acquisition strategy patterned after MFSD. The program turns the systems development process over to industry teams at the earliest stage and challenges industry to develop and design the optimum mix of performance capabilities which can be accommodated within production and life-cycle affordability constraints. This approach has already produced several technological breakthroughs in the initial stage of MFSD development, and the Navy is confident that industry will deliver a revolutionary ship in DD 21.

Planned milestones for the DD 21 program include:
December 1997 - Initiate Request For Proposals
March 1998 - Award multiple concept development contracts
2004-Award contract for the first DD 21.

THE ASSISTANT SECRETARY OF THE NAVY
(Research, Development and Acquisition)
WASHINGTON, D.C. 20350-1000

NOV 24 1997

MEMORANDUM FOR DIRECTOR, DEFENSE ADVANCED RESEARCH PROJECTS AGENCY

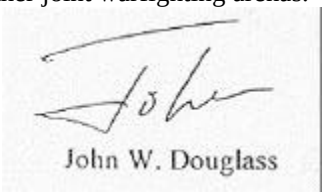
SUBJ: TERMINATION OF ARSENAL SHIP/MARITIME FIRE SUPPORT DEMONSTRATOR EFFORTS

After reviewing Navy budget priorities, the Secretary of the Navy reluctantly determined insufficient funding exists to continue the MFSD program. Accordingly, Phases III and all subsequent phases of the Arsenal Ship/Maritime Fire Support Demonstrator program will not be initiated. The Arsenal Ship Joint Program Office (ASJPO) should complete all Phase II activities and then close down the Joint Program Office. I am deeply disappointed that this truly innovative program that embodied the acquisition reforms and early industry design involvement necessary to affordably procure our future surface combatants was not supported, as requested in the President's Budget.

Phase II payable milestones 5 and 6 are due to be delivered on November 14, 1997, by the three industry consortia. As previously agreed between ASJPO, Deputy Assistant Secretary of the Navy for Ship Programs, the Office of the Chief of Naval Operations (N86), and the SC 21 Program Office, a copy of the Functional Design Report, Life Cycle Cost Analysis, and Production Plan will be provided to the SC 21 Program Office on a "for Government use only" basis. This information will be used by the SC 21 Program Off ice to improve and support the acquisition process for DD 21.

FY98 funding to support payable milestones 5 and 6 was transferred to DARPA, along with sufficient funds, to support smooth and complete transfer of MFSD lessons learned to DD 21 between now and October 1, 1998. ASJPO has agreed to conduct a lessons learned study of the Phase I and II Arsenal Ship efforts, which will be completed prior to 31 December 1997. Management of the Project Office should shift to PMS 500 by January 1, 1998, and funding support for the office should shift to the SC 21 Program Office by October 1, 1998

The completed phases of the Arsenal Ship/MFSD program have provided an excellent return for the investment. These two phases successfully demonstrated that industry, involved early in the ship design process, could develop an optimum mix of performance capabilities that could be accommodated within affordability constraints, successfully demonstrated teaming between combat system integrators and shipyards, and the introduced innovative concepts in reduced manning, automated damage control, topside integration, and modular design. This investment has, and will continue to facilitate DD 21 development, and will pay significant dividends in other joint warfighting arenas.



John W. Douglass

MEMORANDUM OF AGREEMENT
BETWEEN
THE NAVAL SURFACE WARFARE CENTER
AND
DARPA, TACTICAL TECHNOLOGY OFFICE

OBJECTIVE

The objective of this Memorandum of Agreement (MOA) is to facilitate the transfer of the substantial national investment in technology at the activities of the Naval Surface Warfare Center to the industry teams participating in the Arsenal Ship program while maintaining the competitive integrity of the program.

BACKGROUND

The Arsenal Ship program was established to develop and deliver up to six ships for the delivery of large quantities of ordnance in support of land and littoral engagements. The process is being conducted under the Defense Research Project's Agency's (DARPA) Section 845 Agreements Authority. The program is currently structured to be conducted in phases:

I Trade-off studies and design concept development
II Functional design
III Detail design and construction of the Arsenal Ship Demonstrator
IV Demonstrations
V Option for construction of the subsequent Arsenal Ships and conversion of the Arsenal Ship Demonstrator to a Fleet asset
VI Service life support

Because the ships will be developed from the earliest design stages in the private sector, traditional roles and relationships of government organizations must be reconsidered. The industry teams selected for Phase I have approached NSWC activities and DARPA with specific requests for NSWC involvement. This MOA clarifies the role that NSWC will play in Phase I of the Arsenal Ship program. Since this role may change during each phase of the program, this MOA may be modified as the program proceeds.

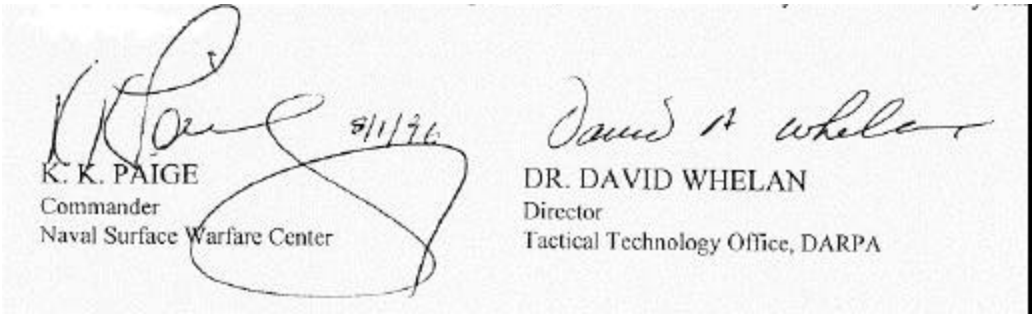
AGREEMENT

1. Warfare Center products and services will be made available for a fee to all industry teams on a non-exclusive basis. Industry requests and a list of delivered products will be provided to the ASJPO.

2. Warfare Center products and services will be limited to the use of test facilities and the provision of objective data, (e.g., results of calculation procedures or tests, models, and simulations,).

3. Source selection evaluators will not have participated in services to industry.

4. Agreements, including funding arrangements, will be made directly between industry teams and the Warfare Center.



MEMORANDUM OF AGREEMENT
BETWEEN
THE NAVAL SURFACE WARFARE CENTER
AND
THE ARSENAL SHIP JOINT PROGRAM OFFICE

OBJECTIVE

The objective of this Memorandum of Agreement (MOA) is to facilitate the transfer of the substantial national investment in technology at the activities of the Naval Surface Warfare Center to the industry teams participating in the Arsenal Ship program while maintaining the competitive integrity of the program. This Phase II MOA supersedes the Phase I MOA for the same program.

BACKGROUND

The Arsenal Ship program was established to develop and deliver up to six ships for the delivery of large quantities of ordnance in support of land and littoral engagements. The process is being conducted under the Defense Advanced Research Projects Agency's (DARPA) Section 845 Agreements Authority. The program is currently structured to be conducted in phases:

I	Trade-off studies and design concept development
II	Functional design
III	Detail design and construction of the Arsenal Ship Demonstrator
IV	Demonstrations
V	Option for construction of the subsequent Arsenal Ships and conversion of the Arsenal Ship Demonstrator to a Fleet asset
VI	Service life support

Because the ships will be developed from the earliest design stages in the private sector, traditional roles and relationships of government organizations must be reconsidered. This MOA clarifies the role that Naval Surface Warfare Center (NSWC) will play in Phase II of the Arsenal Ship program, which is greater in scope than the Phase I role. This role may change again during subsequent phases of the program. Accordingly, this MOA may be modified as the program proceeds.

AGREEMENT

1. Warfare Center products and services will be made available to the two industry teams on a non-exclusive basis. Industry requests and a list of delivered products will be provided to the Arsenal Ship Joint Program Office (ASJPO).

2. Warfare Center personnel may provide technical expertise, upon request, to industry teams in the form of consultation and recommendations or opinions, in addition to performing objective calculations, testing, modeling and simulation. Support available includes but is not limited to the following technical areas:

Hydrodynamics
Vulnerability & Survivability
Signatures
Weapon Systems and Explosive Safety
Combat Systems Integration
Ship, Weapon and Combat System Test & Evaluation Weapon Systems Design
Chemical, Biological & Radiological Defense
Electromagnetic Environmental Effects
Warfare Analysis
Shipboard Environmental Quality (military mission unique requirements)
Shipboard Physical Security
NAVSEA Warfare Center owned (unique) models and simulations

3. Warfare Center personnel will at all times protect the industry teams' proprietary information.

4. Source selection evaluators will not have participated in services to industry teams on this program.

5. Agreements, including funding arrangements, will be made directly between industry teams and Warfare Center activities with the concurrence of Warfare Center Headquarters.

K. K. PAIGE
Commander
Naval Surface Warfare Center

DR. DAVID WHELAN
Director
Tactical Technology Office, DARPA

CAPTAIN CHARLES S. HAMILTON II, USN

Captain Hamilton attended Duke University, graduating in May 1974 with a Bachelor of Science in Zoology, and commissioned in the Navy through the NROTC Program at Duke. Captain Hamilton's early sea tours included: USS HAWKINS (DD 873) [Electronics Material Officer and Combat Information Center Officer]; USS COONTZ (DDG 40) [Fire Control Officer and Missile Officer]; USS CALLAGHAN (DDG 994) [Operations Officer]; and USS Fox (CG-33) [Executive Officer]. In July 1991, he became Commanding Officer USS OBRIEN (DD 975) where he served until June 1993.

Captain Hamilton's educational assignments included: Naval Postgraduate School, Monterey, Ca. where he graduated with distinction with a Masters of Arts in National Security Affairs; and National War College where he graduated with distinction and was awarded a Master of Science in National Security Strategy.

Captain Hamilton's shore duty assignments included: Office of the Chief of Naval Operations as Anti-Submarine Warfare Program Analyst, Administrative Assistant to Director, Program Resource Appraisal Division (OP-91), and VCNO's speech writer; CNO Staff as Head AEGIS Destroyer Section (OP-355F) and Financial Coordinator, AEGIS Cruiser Destroyer Branch; and Military Staff Specialist for Naval Warfare in the Office of the Under Secretary of Defense (Acquisition & Technology).

Captain Hamilton became Program Manager for the Arsenal Ship in May 1996 and remained in place through 31 December 1997.

Mr. J. CHRISTOPHER (Kit) RYAN

Mr. Ryan obtained his undergraduate degree from Webb Institute of Naval Architecture in 1967, followed by a Master Degree in Naval Architecture from MIT in 1969.

Mr. Ryan initially worked for Litton Systems, Advanced Marine Technology Division Los Angeles on the DD-963 project. Upon completion of the DD-963 design effort, Mr. Ryan joined the Department of the Navy as a member of the Naval Ship Engineering Center (NAVSEC), Hyattsville, Md. Advanced Design Group. He had major assignments on the FFG-7 project, the Sea Control Ship project, the nuclear strike cruiser (CSGN), Aegis crusier (CG-47) and several aircraft carrier projects such as the CVV.

In the mid-1980's, Mr. Ryan took on the managment of the Computer Supported Design project within NAVSEA 03 to develop specialized ship design software, which ultimately led to the introduction of commercial CAD/CAM systems in NAVSEA, and the progressive integration of the vast analysis software library with CAD geometry. Recent assignments have included leading the Design, Acquisition and Construction process improvement effort at NAVSEA; being the acting head of Preliminary Design; and being the NAVSEA lead for Simulation-Based Design.

Following graduation from Defense Systems Management College in 1995, Mr. Ryan joined the Navy's Arsenal Ship concept exploration team, where he remained until May 1996 when he became the Technical Director for the Arsenal Ship Joint Program Office.

Ms. CINDY SHAVER

Ms. Shaver has been a Contract Specialist for the Naval Sea Systems Command (SEA 02) since 1989. She served as an contracting intern in the Surface Systems and Undersea Warfare Contracts Divisions, where she received exposure to various major weapon system programs. Beginning in 1991, she has served as a senior contracts negotiator for the Navy's Shipbuilding Division and has been responsible for the award and/or administration of seven major shipbuilding programs. She has experience with both research and production programs in all stages of the system acquisition process, from cradle to grave.

Program experience includes: the NSSN New Attack Submarine construction contract negotiation; the AGOR 24/25 and NOAA Oceanographic Research Ship Construction contract award; the settlement of the terminated T-AO 191/192 Fleet Oiler litigation and assignment of the T-AGOS 23 Oceanographic Surveillance Ship Construction contract to another shipbuilder; the WAGB 20 Coast Guard Polar Icebreaker Ship Construction contract award; the CG 47 AEGIS Class Cruiser, DD 963 SPRUANCE Class Destroyer and DDG 993 KIDD Class Destroyer Combined Planning Yard contract award; the and Arsenal Ship Program Section 845 Other Transaction awards.

Ms. Shaver holds a B.S. degree in Business Administration from George Mason University. She is a graduate of the Department of the Navyís Contracting Career Intern Program and is a member of the Department of the Navyís Acquisition Professional Community with level III certification.

Mr. JOHN A. GRIZZARD

Mr. Grizzard obtained his Bachelor of Science Electrical Engineering degree from Virginia Polytechnic Institute and State University in 1985, followed by Masters in Business Administration from Florida Institute of Technology in 1994.

Mr. Grizzard initially worked for Martin Marietta Orlando Division, Orlando, Florida, where he developed the Master System Test Plan for Supersonic Low Altitude Target (SLAT). Mr. Grizzard joined the Department of the Navy as a member of the Naval Surface Warfare Center Carderock Division, Low Observables group. He served as the Radar Imaging Measurement System (RIMS) Project Manager; the Deployable Signature Measurement System (DSMS) Project Manager; and the Manager, Ship Low Observable Technology Integration office. He establishd the Navy's Topside Integration Working Group including participation as the ONR representative.

Mr. Grizzard joined the Arsenal Ship Joint Program Office as the Survivability Manager in May 1996.

Mr. JOHN G. FRINK

Mr. Frink obtained his Bachelor of Science Physics degree from Michigan State University in 1968, followed by a Masters Degree in Computer Science from the University of Maryland in 1970.

Mr. Frink initially worked with the Naval Surface Weapons Center, White Oak, Md. as the group leader for minicomputer/microprocessor applications, the MK 48 torpedo, Captor Mine, and early Navy High Energy Laser efforts. Mr. Frink served four years as a commercial consultant, where he developed the hardware architecture and real-time control programs for the initial series of computerized Versatran industrial robots. In 1978 Mr. Frink joined the Johns Hopkins University, Applied Physics Laboratory where he held various supervisory and technical positions in the Navy Warfare Analysis Department and the Fleet Systems Department. Mr. Frink is a specialist in distributed systems and was awarded a patent for "Intercomputer Communications Based on Message Broadcasting with Receiver Selection". He had major assignments on the following programs: LEAP; CEC Test Coordination oversight; internal Applied Physics Laboratory initiatives in DIS, IW; HiPerD; Aegis; and EA6B/EF111 EW ADCAP upgrades. Mr. Frink recently taught a graduate level Advanced Technology Seminar in the Technical Management curriculum of the JHU Whiting School of Engineering. He is a current member of the IEEE, the Computer Society, and the Association of Old Crows.

Mr. Frink joined the Arsenal Ship Joint Program Office in February 1997 as the C4I Manager.

Mr. RICHARD L. DUNN

Mr. Dunn has been the General Counsel of the Defense Advanced Research Projects Agency since 1987. From 1979 to 1980 he was an associate in the Washington law firm of Sullivan and Beauregard. From 1980 to 1987 he was with the National Aeronautics and Space Administration where his assignments included serving as counsel to the Space Commercialization Task Force and as Deputy Associate General Counsel.

At the Defense Advanced Research Projects Agency, Mr. Dunn has pioneered innovative techniques to support science and technology projects. Mr. Dunn was responsible for the enactment of legislation which authorizes DARPA to enter into cooperative relationships with commercial companies or "partnerships" of companies and other organizations. In response to DARPA's successful use of this authority Congress substantially increased DARPA's budget and encouraged it to sponsor R&D consortia. Most recently Mr. Dunn obtained legislative authority for DARPA to conduct military prototype projects outside the laws and regulations applicable to the procurement system. Several projects using this authority are currently underway at DARPA.

He is a graduate of the University of New Hampshire (B.A. cum laude, 1966), the University of Maryland (J.D. 1969), and George Washington University (LL.M with Highest Honors 1976). Mr. Dunn was on activity duty as a Judge Advocate in the U.S. Air Force from 1970 to 1979.

Ms. DIANE M. SIDEBOTTOM

Ms. Sidebottom is Assistant General Counsel for the Defense Advanced Research Projects Agency (DARPA) in Arlington, Virginia. Her duties include providing counsel for DARPA's Other Transactions for Prototypes and Research agreements in all aspects of agreement formation and administration. She also advises the agency on intellectual property

and Internet-related issues. Prior to joining DARPA, Ms. Sidebottom was an attorney-advisor at the Defense Logistics Agency (DLA) specializing in the suspension and debarment of Government contractors. She also served on the task force supporting the Section 800 Panel, which examined over 800 procurement and acquisition laws and provided recommendations to streamline the acquisition process. She is a graduate of the University of Colorado and Thomas M. Cooley Law School

Mr. JOHN H. ABLARD

Mr. Ablard is a Professional Contracts Manager with thirty years of federal government experience. He has worked in all branches of the military services, with experiences ranging from small purchases and local procurement supporting a military base to World-wide communications and ADP systems. The last twenty (20) years have been in what is now called Science and Technology contracting. This is the portion of the R&D cycle where basic technologies are discovered and first exploited. His previous assignment was as supervisor and manager of a large contracting operation for the Naval Research Laboratory, where he received the Navy Meritorious Civilian Service Award in 1990. At DARPA he is furthering the development of new technologies through utilization of new contracting instruments, such as, "Other Transactions" under the authority of 10 USC 2371 and commercial R&D contracts. He received the DoD Exceptional Civilian Service Award in 1997.

Mr. Ablard is involved in the High Altitude Long Endurance Unmanned Aerial Vehicle Projects (Tier II+ and Tier III- Programs) and the joint DARPA/Navy Arsenal Ship Program where these new contracting instruments are being utilized. He has a B.A. degree in History and Political Sciences from Ottawa University, Ottawa, Kansas and a Master of Sciences in Management from the University of Utah. He is a member of the National Contracts Management Association.

Mr. JOHN J. TURNER

Mr. Turner is Senior Vice President of Syntek Technologies, Inc. since 1993. He is a registered Professional Engineer with forty years experience in ship design, construction and operations. He is a retired Engineering Duty Officer with assignments in shipyards, design activities, and acquisition and fleet support projects. Before joining Syntek he was Executive Vice President and Chief Operating Officer of JJH, Inc. For the previous 10 years he filled senior management and technical positions at NKF Engineering, Inc. He is a graduate of the U. S. Naval Academy and received an M.S. and the Naval Engineers degrees from M.I.T. He is a member of Society of Naval Architects and Marine Engineers, American Society of Naval Engineers and other professional organizations.

Dr. ROBERT S. JOHNSON

Dr. Johnson has been a Vice President of Syntek Technologies, Inc. since 1994. He has 39 years experience in ship design, systems engineering and management in which he consults for Naval Commands, the Defense Advanced Research Projects Agency, and commercial clients. He has served in the Naval Sea Systems Command, as Deputy Chief

Engineer, Total Ship Engineering; Director, Field Activities Support Group; Director, Field Operations Subgroup; and Technical Director, Ship Design. He was President of the Ship Engineering and Design of Advanced Marine Enterprises; and Manager, Ship Design, Westinghouse Defense & Electronics Center. He is active in professional societies: a Fellow of the Society of Naval Architecture and Marine Engineers, past member of its National Papers Committee, Editor of *Marine Technology*, and a Life Member, American Society of Naval Engineers (former Member of Council and By-Laws Committee Chairman). He holds the B.S. from Webb Institute, M.S.E. from George Washington University, and D. Eng from the University of California at Berkeley.

Mr. RONALD K. KISS

Mr. Kiss has been Vice President of Syntek Technologies, Inc. for Systems Development since 1996. He has 35 years experience in ship design and ship acquisition. He has served as the Deputy Assistant Secretary of the Navy for Ship Programs; Executive Director for Amphibious, Auxiliary, Mine and Sealift Ships at the Naval Sea Systems Command; Acting Associate Administrator for Shipbuilding and Ship Operations, Director of the Office of Ship Construction, and Chief of the Division of Ship Design at the Maritime Administration. He has been selected to become the President of Webb Institute and will assume that position in 1999. He is active in professional societies: past President of the Society of Naval Architects and Marine Engineers, member of its Executive Committee and Council, and Chairman of its Nominating Committee, past Vice President of the American Society of Naval Engineers, and member of the Royal Institute of Naval Architects. He holds the B.S. from Webb Institute, M.S. from the University of California at Berkeley, completed the Harvard Business School and Sloan School (M.I.T.) Executive Programs.

Mr. ROBERT C. PERCIVAL

Mr. Percival has been Vice President of Syntek Technologies, Inc. for DARPA Programs since 1996. He has thirty two years experience in ship design, acquisition management, construction and operations. He is a retired Engineering Duty Officer with assignments in research activities, design activities, and acquisition and fleet support projects. Before joining Syntek he was Director of Surface Ship Design and Systems Engineering, Director of Research and Development, Director of Concept Design, and Director of Signature Control at the Naval Sea Systems Command. Previously he was an Acquisition Mannager in the Aegis Program Office delivering the SPY-1B and SPY-1D radar systems. He is a graduate of the U. S. Naval Academy and received an M.S. and the Ocean Engineers degrees from M.I.T. and the Executive Management Program at Penn State University. He is a member of Society of Naval Architects and Marine Engineers, American Society of Naval Engineers and other professional organizations.

Mr. BRUCE P. DYER

Mr. Dyer has been Vice President of Syntek Technologies, Inc. since 1996. He has thirty two years experience in prorgram management and military operations. He is a retired Naval Special Warfare Officer who qualified as an Acquisition Professional. Before joining

Syntek he was a Program Manager at the Defense Advanced Research Projects Agency and the Program Manager for a sensitive classified Major Defense Acquisition program at the Naval Sea Systems Command. Previously he commanded the Naval Special Warfare Task Group, Middle East during Earnest Will operations which included Patrol Craft, Army Helicopters, intelligence collection assets, as well as special forces personnel. He is a graduate of the U. S. Naval Academy and received an M.S. in Systems management from the University of Southern California.. He completed the Executive Development Program at Cornell University. He is a member of the Institute of Electrical Engineers, U. S. Naval Institute and other professional organizations.

Mr. MICHAEL YERMAKOV

Mr. Yermakov is Director of Strategic Planning at Syntek Technologies, Inc. since 1997. He has 12 years experience in ship design, systems engineering and management in which he consults for Naval Commands, the U.S. Coast Guard, the Advanced Research Projects Agency, and commercial clients. He has served in the Naval Sea Systems Command as the Chief Systems Engineer for the SC-21 Program, a Ship Design Principal Naval Architect and lead the development and deployment of special systems for anti-terrorist operations. He managed the assessment of new ship acquisition and R&D programs in the Office of the Chief of Naval Operations and served as Chairman of NATO Group 6. He is a member of the Society of Naval Architecture and Marine Engineers, member of its Advanced Naval Vehicles Committee, and a Member of the Association of Scientists and Engineers. He holds the B.S from the University of California at Berkeley and graduated from the Acquisition Program Manager's six month course at the Defense Systems Management College.

Mr. DAVID SCHWIERING

Mr. David Schwiering has been the Program Manager for Vail Research and Technology providing support to the Arsenal Ship Joint Program Office since 1997. He is a retired Surface Warfare Officer with command assignments afloat and ashore. He served as Head of Programs and Budget for both Surface and Expeditionary Warfare and was the lead analyst for the Research and Development Appropriation in the Office of the Navy Comptroller. He holds a B.A. from Waynesburg College and an M.S. in Financial Management from the Naval Post Graduate School.

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